

Your Bachelor or Master Thesis at IRS

The basics

Welcome to the Institute of Space Systems (*Institut für Raumfahrtssysteme* or *IRS*) of the University of Stuttgart! This handout will provide you with some information and valuable hints to help you get started on your Bachelor or Master thesis at IRS. As this information sheet is neither comprehensive nor definite and is continuously being improved, please refer to your thesis supervisor for potential changes or clarification.

First of all, here you will find the contact data both of your responsible professor as well as your thesis supervisor, who will guide, instruct and assist you in the following months:

Your responsible professor:

Priv.-Doz. Dr.-Ing. Georg Herdrich

E-Mail: herdrich@irs.uni-stuttgart.de

Tel.: +49 711 685-62412

Office: Room 2.06, 2nd floor**Your supervisor:**

[Name]

E-Mail:

Tel.:

Desk:

Your supervisor

At the beginning of your stay at IRS, your supervisor will organise a student account for you, provide you with an introduction to his or her work and your thesis topic, your task description and with the necessary software tools. If you will be working in one of the IRS laboratories, he or she will introduce you to safety regulations and/or refer you to a safety briefing. Your supervisor may also suggest some literature for you to get started.

You will be provided with a student IRS account, which will allow you to access IRS and university resources from any terminal within the IRS computer pool on the second floor. In addition, you may have your personal computer registered for wireless access to IRS resources. Accessing certain digital resources may require prior clearance through your supervisor and/or responsible professor.

You will be expected and encouraged to work independently, to develop your own ideas and to be creative in finding solutions to problems that present themselves. Be sure to present and discuss the progress of your thesis work on a regular basis with your supervisor, and to keep him or her updated with regards to your current activities.

Depending on the specifics of your topic, you may choose freely when and where to work on your thesis. In some cases, your thesis requires laboratory work or similar tasks that require your physical presence. Please be sure to honour appointments made with your supervisor. As a courtesy, please inform him or her in a timely fashion, should you not be able to make an appointment, or if you plan to be absent for any extended length of time.

Completing your thesis

Your supervisor will provide you with at least one comprehensive feedback of your report, after which you should address and/or implement his or her suggestions. Once your supervisor agrees that your manuscript is suitable for submission, you can forward it to the responsible professor who will also review it. Please do not print your report prior to the responsible professor's approval and make sure that it adheres to the IRS thesis format. You are urged to anticipate that providing comments to your manuscript takes time, usually approximately two weeks for each major iteration, and to consider this in your planning. Your thesis should be completed within four (Bachelor thesis) or six months (Master

thesis) from the starting date. Extensions are usually possible, but must be sanctioned by the sending university.

Upon submission of the printed version, of which one is required for each of your supervisors and one for the responsible professor, you are expected to hold a 20-minute presentation of your work. Please be advised that your written report must be completed by the time you hold your presentation. Your supervisor will usually offer to invite one or two of his or her colleagues to provide preliminary feedback to a test presentation a few days beforehand.

In addition to the written report and the presentation, you are expected to submit all data you have generated in the course of your thesis work on a suitable disk format, preferably a USB drive. The data to be submitted includes your report and presentation in digital form as well as any programs, scripts, images and datasets that you have written or generated in suitable formats allowing for further processing.

What should the report look like?

In its final form, the print version of your thesis should be bound in conformance with IRS standards. This requires that a blue cardboard back and cover, which can both be provided by your supervisor at IRS, be used. The spine of the book must be yellow for Bachelor theses or red for Master theses. Use single-sided print only. Please adhere the official guidelines on student theses conducted at IRS, which you can find under <http://www.irs.uni-stuttgart.de/lehre/> [in German].

The report must (or may, if so stated) include the following elements:

- A **title page**: This should be adapted to the aforementioned blue book cover and show the title of the thesis, the author's name as well as the IRS document number provided to you by your supervisor near the end of your stay. The remainder of the page, which may be covered by the blue book cover, should include the month in which the thesis was completed as well as the logos representing the Institute of Space Systems (IRS), the University of Stuttgart, and your sending university (if applicable).
- A copy of the **task description**, including the **declaration** (affidavit) signed both by yourself and by the responsible professor at IRS, which will be provided by your supervisor. Any submitted copy of your thesis, including the digital version, require the inclusion of a scan featuring all needed signatures without exception. Please note that the copy of your thesis containing the originally signed task description is to be submitted to the responsible professor.
- An **abstract**, both in the language in which the thesis is written (i.e. German, if applicable) and in English. The abstract provides a concise overview of the contents and findings and serves to help potential readers decide whether the contents are of relevance to them. Keep introductory content to a minimum, as the abstract should showcase specifically your own work, its methods and central findings. A length of 200 to 400 words is recommended.
- **Acknowledgements** are optional and thus entirely subject to your discretion.
- A **table of contents** helps the reader navigate your thesis. Most word processing software packages can create a TOC automatically. Please try to keep it within two pages length. If necessary, restrict the number of header levels shown in the table of contents to two (chapters and main sections).
- A **list of symbols**: All physical constants, symbols and acronyms used throughout your work should be defined here. You may find it useful to subdivide this list, i.e. by listing acronyms, physical constants, latin symbols, greek symbols and indices separately.
- **List of figures** and **list of tables**: Lists of all figures/tables presented in your report, including identifying labels (numbers), captions (or a shortened version thereof) and page numbers. Many word processing software packages can create these lists automatically. Please make

sure that all figure and table captions are unique and descriptive, and that no citations appear in the list. In *LaTeX*, e.g. this can be achieved by providing a short caption to each figure and table by using the command `\caption[short version]{long version with references ~\cite{REF}}`.

- An **introduction** is essential to provide the reader with context and a general understanding of your topic as well as to motivate your own work. Start from a general context, then work your way into your specific subject. Assume that the reader is a trained aerospace engineer with no particular knowledge of your subject. As an example, your reader will most likely recollect how orbital mechanics and rockets work, yet he or she may be unfamiliar with the challenges and specifics of atmospheric re-entry or electric space propulsion. Motivate your work by building on the central issues you have laid out and maintain a logical argument. End your introduction by providing an overview of how your thesis is structured. The introduction constitutes the first of your numbered chapters.
- **Your actual contents:** This is where you present your actual work in at least three separate chapters. We strongly recommend presenting the must-know fundamentals and state of the art, as determined from available literature sources first, and specifying your task accordingly. Proceed with describing your experimental setup / numerical case / modelling approach / construction / review / etc., before presenting and discussing your obtained results in detail. Remember to maintain a logical argument structure and to never assume that the reader has any previous knowledge about anything that you have not yet discussed or which could be expected from a trained aerospace engineer with little specialist knowledge. It is suggested that you discuss a suitable structure of your contents with your supervisor before documenting them in full.
- **Conclusions:** After your work has been presented and discussed, draw your conclusions. Try to evaluate the implications of your thesis work in the larger context and to identify potential weaknesses. In general, a **summary** and an **outlook** are presented alongside the conclusions towards the end of your main body of text. A summary should summarise your thesis work and its relevant results, thus helping the reader follow your conclusions. An outlook provides suggestions and ideas towards further continuing and elaborating work on your subject and addressing identified weaknesses and shortcomings. Summary, conclusions and outlook may either be presented individually or merged in part or in full, depending on your preferences, the content and the length of your report.
- The **bibliography** lists all literature sources you have cited throughout your report in the order of citation. Many writing software packages can help you generate the bibliography (e.g. *BibTeX* for *LaTeX*). As a courtesy to the authors, please list all of them and dispense with shortcuts such as “et al.” We recommend using the AIAA bibliography style, and to include Digital Object Identifiers (DOI numbers) where available. Please provide sufficient information for readers to find a specific source, depending on its type. For different types of literature sources, please include the following information (optional information in brackets):
 - *Journal article:* Authors, title, journal, volume (and number), (publisher), year, ID or page numbers, (DOI number).
 - *Conference article:* Authors, title, conference, place, year, ID or page number if available, (DOI number).
 - *Book:* Authors, title, publisher, volume and edition, year, ISBN.
 - *Book chapter:* Authors, chapter title, book title, editors, publisher, volume and edition, year, page numbers.
 - *Thesis:* Author, title, year, type of thesis, institution, (DOI number).
 - *Online resource:* Title, author and/or organisation, URL, date last accessed.

Other types of sources may be permitted, provided you can provide enough information for the reader to retrieve them. Please clarify these cases with your supervisor. Many publishers and search tools such as google scholar provide you with the option of exporting bibliography data directly and conveniently for journal articles. Make frequent use of this, but always double-check for mistakes or missing data.

- An **appendix** can be used to provide supplementary data or additional information, which is linked to your topic but is not immediately essential to following and understanding your thesis work. This may, for example, include documentation of programs you have written through flow charts, technical drawings, databases generated as an output of your thesis, etc. The appendix does not contribute to your content page count. Appendices are usually numbered using capital letters, i.e. A, B, C, etc.

Writing in English

If you plan to write your thesis in English, your supervisor may ask you to provide him or her with a written sample early on (e.g. a preliminary two-page introduction) to help assess your writing skills and point out common “pet” mistakes, which you can then try to avoid.

You may use either British English (BE) or American English (AE) spelling to your preference, but please remain consistent.

While style, grammar, etc. will per se not factor into your evaluation, please ensure that your sentences convey the intended meaning clearly and are logically structured. Depending on your native language, it may help translating them back literally to see whether they make sense. The primary aim is to convey your ideas and explanations unambiguously, i.e. using precise language, and in a manner that the reader can follow. In general, keeping your sentences short will make your work more accessible to readers. You may also find it helpful to ask for advice or feedback from a native speaker.

If you are unsure regarding the spelling and meaning of specific words, please do not hesitate to make generous use of helpful online resources (e.g. dictionaries and translators) and the spell check function of your word processing software. Even if you consider your English writing skills less than ideal, using such tools and putting care and effort into avoiding unnecessary spelling mistakes will nonetheless leave readers with a good impression.

Frequently Asked Questions (FAQ)

- **Which writing software should I use?**

You may use any widely distributed software package, such as *Microsoft Word*, *LaTeX* or *Open Office*, as you prefer. However, when asked, many supervisors at IRS will recommend that you use *LaTeX*, as it may save you work with regards to formatting, bibliography management, internal referencing and mathematical formulas, allowing you to concentrate on the contents. Your supervisor may be able to provide you with a suitable template upon request.

- **How much should I write?**

Page counts usually only consider the content pages, starting from the introduction and finishing with the conclusions or bibliography, i.e. encompassing all numbered chapters. By this standard, a Bachelor thesis documentation at IRS typically amounts to 30 to 40 pages. Master theses usually fill 40 to 60 pages. Please discuss any significant deviations from these page counts (> +20) with your supervisor.

- **How do I cite properly?**

Please avoid copying entire passages of text from other sources entirely, unless it is a particularly interesting literal quote, where the wording in itself is of interest. Otherwise,

reproduce the relevant information from your source in your own words and include the numerical reference in squared brackets at a suitable position, behind either a keyword, the sentence, or the paragraph. Literal quotes must clearly be marked as such through text formatting and introduced as such. Naturally, the source of this quote must be provided, also. References are numbered in the order they first appear. If you wish to refer to multiple references at once, separate them using a comma within the same brackets. However, be sure to maintain the correct numerical order, e.g. [3, 14].

- **How and when do I reference figures, tables, chapters, sections, and appendices?**

Every figure and table presented in your thesis must be referenced explicitly in the text before it is shown. Use the associated label to identify it explicitly, e.g. “Figure 14” or “Table 3”. You can alternatively shorten these, e.g. “Fig. 14” and “Tab. 3”, but please remain consistent throughout your work. Such labels are considered proper nouns, and are thus capitalised. If you are not using the label to refer to a specific figure or table, they are not capitalised. The same applies to chapters, sections, subsections, and appendices. Here are a few examples:

- “In Chapter 4, figures and tables illustrating this issue are presented.”
- “The thrust efficiency is plotted over the exhaust velocity in Fig. 23.”
- “The following subsections provide more detailed information on specific subsystems, an overview of which is given in Table 9.”

Please try to avoid using potentially ambiguous references such as “the following table” or “the above figure”, by referring to these using their unique label. Because some word processors such as *LaTeX* may position these objects automatically, and because the reader may not always find these positioning references as obvious as the author does, this could otherwise cause confusion.

- **Colour or monochrome (“black and white”)?**

While monochrome is considered standard at IRS, you are free to prepare your report in colour. However, please ensure that all figures, diagrams and plots are clearly intelligible in monochrome also, in order to make them accessible to readers with an impaired colour vision and intelligible on monochrome photocopies (see also the “General hints” section).

- **How is my work evaluated and by whom?**

If you are enrolled as a regular student at the University of Stuttgart, your responsible professor will consult with your supervisor to decide upon a grade for your thesis after having read your report and seen the presentation. Your grade will be influenced by a variety of criteria, such as the extent to which you have fulfilled your thesis work in the given time considering its complexity, personal initiative, independence, conscientiousness and methodology with which you have conducted your work, the structural and written intelligibility and coherence of your report, as well as the quality of your final presentation. If you are based at a third-party university, a submission of the report in IRS format and a presentation on the IRS premises are still mandatory, but the grading of your thesis may be subject to the rules of your home university.

General hints

Here are a few general hints and tips to help you write your report:

- Remember that the intended reader has approximately the same level of knowledge as you had when you began working on your thesis. Guide him or her through your work with this in mind.
- Do not stray from the topic. If information is irrelevant to your thesis, do not waste pages or your reader's time by elaborating it in detail.
- When writing your report, write as if neither you nor the reader exists (exceptions include e.g. the acknowledgements). Accordingly, please avoid personal pronouns such as "I", "you", "one" or "we". In scientific writing, an accordingly expressed detachment from one's own work gives it a more professional and objective appearance. You may make use of the passive voice when describing your own actions, however you can bring variety into your writing by using the active form when describing processes not directly involving yourself or activities of third parties.
- We recommend using the simple present tense (e.g. "it is") for the most part when writing your report. It is suitable to describe phenomena, functionalities, permanent facility setups and facts or well-established theories. Specific actions conducted by yourself, your team or third parties, e.g. experiments, are best described in the simple past tense (e.g. "it was"). This includes descriptions of preparations, adjustments and calibrations e.g. for a dedicated and temporary experimental setup. Avoid the present continuous tense (e.g. "it is going") completely, as this implies that something is occurring right now. Similarly, do not use the past continuous tense ("it was going").
- Used wisely, pictures and diagrams may bring the reader clarity where written explanations fail to do so.
- Please ensure that figures, tables, words or URLs do not extend beyond the text column width or length.
- Header columns or rows in tables should be written in bold to help the reader distinguish them from the actual contents. In general, you are free to format tables in a style according to your preference, but please remain consistent throughout your report.
- We encourage familiarising yourself with and using vector graphic formats (e.g. .pdf, .eps or .emf) for line art, such as plots, diagrams, technical drawings and flow charts. This will greatly increase the clarity and quality of such figures, while considerably reducing the required disk space of your digital report. Vector graphics can be created and modified using the Open Source software package *Inkscape* (all formats, see also "Useful tools"), but also using *MS Office* products such as *Word* and *Power Point*. Most software packages with which you can create data plots and line art, such as *MATLAB*[®] will allow you to export these in a vector format.
- Plots and diagrams should be clearly intelligible in monochrome ("black and white"), in order to render them intelligible on monochrome photocopies and to readers with impaired colour vision. Distinguish individual lines and data points by varying line styles, shades, marker styles etc. as opposed to merely using different colours, and try not to clutter diagrams with too much data at once. Please use sufficiently large fonts and thick lines, and keep the style of your plots consistent throughout your report. If you are not sure whether a certain plot or diagram is suitable for your report, print or copy the page in monochrome and see for yourself.

Useful tools

Here is a list of some Open Source software tools you may find useful:

- **TeXstudio:** A *LaTeX* editor featuring many helpful functions such as spell checking.
- **Inkscape:** A powerful vector image editing software.
- **Gimp:** A raster image editing software.
- **Notepad++:** A text and data editor, particularly suitable for exploring experiment data files.
- **Engauge:** A software tool, which allows you to efficiently digitize data from image sources (e.g. diagrams and plots from articles).

Online resources

These resources provide additional guidelines and useful information for writing scientific reports:

- **Official IRS guidelines for student theses:** <http://www.irs.uni-stuttgart.de/lehre/>
- **The NIST Reference on Constants, Units, and Uncertainty** (Well-established standard for the display and formatting of scientific formulae, units, constants, uncertainties, etc.):
<https://physics.nist.gov/cuu/Units/rules.html>
- **The English Page** (Writing style guide with useful hints and tutorials):
<http://www.englishpage.com>
- **The Chicago Manual of Style** (advanced writing):
<http://www.chicagomanualofstyle.org/home.html>