Bachelor's project at the Department of Physics and Astronomy

Peter Balling and Hans Kjeldsen
The Education Committee at the Department of Physics and Astronomy, Aarhus University
June 2019

Table of contents:

Carrying out a Bachelor's Project at the Department of Physics and Astronomy

1. Introduction

To obtain a bachelor's degree a student must among others carry out a bachelor's project, rated to a workload of 10 ECTS credits (1/6 FTE units) or 15 ECTS credits (1/4 FTE units). In practice, the project should therefore have a scope equivalent to approximately 275 hours' full-time work (including preparation and project writing) to achieve 10 ECTS credits, and approximately 400 hours' full-time work to achieve 15 ECTS credits. The work on a bachelor's project is typically carried out during one semester (6 months) which means that the workload equals 1/3 or 1/2 of the time the student is expected to spend on a full-time study programme.

The final project report concludes the bachelor's project and forms the basis for the assessment of the project. An external evaluator (co-examiner) takes part in the assessment of the report. The report is assessed in accordance with the Danish 7-point grading scale. For projects carried out during the spring semester, the final report must be submitted no later than 15 June. If carried out during the autumn semester, the report must be submitted no later than 15 January.

You register your bachelor's project the same way that you register for other courses. Just like other courses, the bachelor's project has a page on BlackBoard, which you have to check regularly. You will be asked to submit the subject of your project, your choice of supervisor, and, finally, also the title of your project (do not forget to check your mailbox post.au.dk. The final report must be submitted digitally via https://eksamen.au.dk/.

Below, you will find some practical and formal guidelines for the project work and the structure of the bachelor's project report.

2. Formalities: Excerpts from the academic Regulations regarding Bachelor's Projects

The bachelor's project is an individual project, which is to be finalised with a written report. When the project is finished, the student must have demonstrated the ability to

- Formulate an academic issue based on relevant literature
- Complete a written report using the subject-related methodologies
- Apply subject-related theories and methodologies to an academic issue
- Analyse an academic issue by applying relevant literature
- Discuss and put into perspective an academic issue

The final report must include a summary in English. The summary forms part of the overall assessment of the student's written expression skills in connection with the project. You will find more information under the current academic regulations [1] and the course description for bachelor's projects [2].

3. Objective

As apparent from the Academic Regulations above, the objective of the bachelor's project is that the students demonstrate their abilities to work independently on an academic topic, which includes key elements of research work including the application of analysis methods, theory, the use of academic literature and demonstration of written skills and discussion of the relevant academic topic. Obviously, it is impossible to conduct a large research project within the framework of a bachelor's project, but, then again, the bachelor's project is an academic project, during which the student works independently within a defined research area.

4. Selection of Supervisor

When the student is to choose a bachelor's project, he or she should contact the department. It is customary to discuss potential projects with more than one researcher before making the final choice. It is a good idea to seek inspiration in the bachelor's project description available on IFA's website [3]:

In connection with the first meeting on the prospectives for carrying out a bachelor's project, it is obvious to discuss:

- Which projects are offered by the relevant researcher in terms of a 10-ECTS or 15 ECTS bachelor's project? Which activities are expected?
- Does the project have a well-defined research question and a general structure, which, in terms of scope and time, matches the student's study programme?
- In which fields does the student have his/her strongest competences and interests? How should the project be structured as to the amount of
    - Theoretical work, models, analysis of models
    - Experiments/observations and analysis of data (possibly your own)
    - Analysis of existing literature, potentially a project primarily based on published results and discussion of the relevant scientific literature.

5. Preparation of a Project Schedule

Once you have decided on a project, you and your supervisor must prepare the overall topic and a time schedule for the entire process. It is a good idea to set up a number of "milestones", continuously to evaluate the project. Typical "milestones" could be:

- Experimental / observational work begins / ends
- Literature search begins / ends
- Analysis of data begins / ends
- Theoretical models are constructed; computations conducted
- Theoretical and experimental results are compared
- The writing process is initiated
- The first version of the report has been completed

It is important to bear in mind that the only product of the project that the external co-examiner will actually see is the report. Therefore, the writing process should be highly prioritized, and the complete work substantiated and discussed in the report. Therefore, it must be clear, which part of the work is carried out by the student and which part is carried out by others, in which case these must be cited. Analysing and discussing the results achieved are typically the stages of the project, where the student has the least experience, and where unsecurities may occur in terms of what exactly needs to be done.

6. Supervision Agreements

It is important to agree on how supervision should take place. Generally, regular supervision meetings (e.g. once a week) are a good way to keep the momentum of the project and ensure that it does not come to a standstill. Decide if supervision should primarily take place through meetings, or if e-mails are preferred for clarification, etc. The supervision may vary depending on the stage of the project you have reached.

It is important to note that supervision during the writing process is part of the supervisor's job. As this is the student's first major written assignment, it is important to be able to discuss his or her priorities with the supervisor. This part of the supervision may vary, but the process will typically include these three elements:

- The supervisor will comment on the students' outline, e.g. as a draft of the table of contents
- The supervisor reads a part of the report (e.g. five pages) at a relatively early stage in the process. This way, any general linguistic or structural errors can be caught
- The student and the supervisor discuss the key paragraphs in the report (analysis and discussion). The primary goal is that the supervisor is given the chance to comment on the structure and validity of the reasoning.

Please note that obviously, the supervisor is not correcting the report before it is submitted; this would make the evaluation process impossible.

7. The Work and the Writing process

A typical bachelor's project contains the stages outlined under point 5. It is important to work determinedly and to make sure to reach the "milestones", and that the work progresses. Finishing everything in the last moment is impossible! Make regular notes of the results achieved; it may be difficult to remember details you have not recorded, if the writing process begins months later. Remember to write small paragraphs or a single chapter at an early stage, and remember that it is certainly not necessary to start by writing the introduction to the final report. The chapter on experimental work could be written, e.g., when the lab work has been completed. Create a schedule and set targets and milestones for the process.

It is important to bear in mind that it takes time to communicate professionally. In the report, the student must convey the work that he or she has undertaken during the project, and focus on the conclusions that can be drawn from the work and its comparison with the existing scientific literature. Make use of illustrations and tables, and write in a clear and comprehensible language and focus on methods and results. Clarify your independent contribution and cite the literature consistently. Assertions and results without references are expected to be achieved through the project work. Avoid colloquial language.

The report must not exceed 30 pages in length, excluding the front page, summery, table of contents and bibliography (applicable for both 10 and 15 ETCS). It is important to bear this in mind throughout the entire writing process. There is not enough space to write a long and comprehensive introduction and discuss every theory in detail. The project report is not a textbook on the topic. Use e.g. references to sources where the theory has already been discussed, and point out only the key equations and theories.

The level of complexity of the report must be such that your fellow students can understand it without prior knowledge of the topic.

Additional guidance for preparing the report can be found in the enclosed "Guide to Bachelor Report Writing"

A guide to writing your Final Project Report

1. Introduction

This guide intends to help you produce a final (bachelor's) project report. However, do not follow it slavishly. The actual structure of the report is up to you, and there is more than just one correct approach. We hope that this guide will help you make this choice in a qualified way and help you avoid the "typical" mistakes.

2. Language

Your ability to express yourself in writing is included in the assessment of your project. You may write in Danish or English, and there are advantages and disadvantages with both; ask your supervisor. As mentioned before, your communication skills will be assessed. Therefore, write your report in English only if you trust your English writing skills, and if your communication skills are not hampered. If you write in Danish, avoid using anglicisms. We have many fine Danish words - use these instead. Another typical mistake is not writing the words in one word - in Danish one word, in English two words. The report must include a summary in English. It would be natural also to include a summary in Danish, especially if the report is written in English.

The report's level of complexity should be such that one of your fellow students can understand it without prior knowledge of the topic. It is fully acceptable to assume knowledge of the theory you have obtained in courses you have completed. The language should be scientific and precise. Avoid slang and colloquial language.

It is a good idea to have someone else read your report, as it comes to an end; it is easy to overlook one's own mistakes. If you believe that you have particular problems with writing (such as dyslexia), it is important to point this out to your supervisor at an early stage so that he or she can adjust the scope of your project leaving you with sufficient time for the writing process. You could also contact the University's Counselling and Support Unit [4].

3. Text Editor and Typography

There are no requirements as to which text editor you should use. Simply use the one you already know. LaTeX (or its derivatives) is very useful in terms of handling large reports with many references and equations. However, if you are not familiar with the program, you should allow extra time to acquaint yourself with it. Remember to run the spell-checker to catch (some of) your typing errors.

We recommended that you use a simple typography in the report. Select a font and size which will make the text easy to read (for instance size 11 or 12 on A4 paper). Write a full-page text instead of using two columns. Select a font size, spacing and margins so that one page containing only text will consist of max 2,400 characters including spacing. A report must not exceed 30 pages, excluding the front page, abstract, table of contents and bibliography. Appendices exceeding 30 pages are typically not considered in the overall assessment; consult your supervisor.

4. Report Structure

As previously mentioned, there are many ways you can structure your report. The following list is only a guideline:

4.1 Front page

State the title, your name and student registration number, the name of your supervisor, department, Aarhus University and the date you hand in the report. Optionally, insert a nice illustration or figure from your report or a suitable logo.

4.2 Table of Contents

It is recommended to generate this automatically; it is very simple in LaTeX - in MS Word, make sure to use the heading system for your sections.

4.3 Preface

Describe the report. This is where you describe the assumed knowledge of the reader. If you wish to thank people who have helped you during the project, this is a place to do this (or you can do so elsewhere in the report). We also recommend that you account for your own qualifications by e.g. mentioning elective courses relevant to the project, which you either have or have not taken.

4.4 Introduction

Describe the background and motivation for your report as well as the aim of the project. As background information, you may incorporate existing work and literature, but bear in mind that it should not become too comprehensive. It may be advantageous to postpone a profound discussion to the discussion section. Make sure that the scientific topics, you are describing and presenting, are the ones that you have discussed in your project, and that the questions you are discussing, are more or less those you seek answers to in your project.

4.5 Experiments and theory

This part of the report may be structured in more than one way; consider which is fitting for your project, and discuss it with your supervisor.

If your describe experimental setups in your report, these must be described in details such that, in principle, the reader can reproduce these experiments based on your description. Avoid describing the equipment mode of operation in every little detail, if it was not a central part of your lab work. Avoid using "lab jargon" to describe equipment and methods.

Your theory section must relate directly to the project. Avoid writing a lot of underlying theory, if you can put in a good reference. On the other hand, if you have spent much of your time getting familiar with a particular theoretical description, it would make sense to include this in the report. If you explain theoretical inferences, you must have completed the steps from A to B *or* you should refer to a valid reference (see item 4.10 “References”).

Generally, you should make sure that the report reflects the great efforts you have put into your project! This could comprise building-up equipment (or just using it), developing new analysis methods, software or deriving theoretical descriptions.

4.6 Results

Go through the results achieved. Choose a logical order for the presentation; it does not have to be the order in which the experiments and the calculations were made! The results must be substantiated by means of figures and tables. To ease structuring this section, you can start by making an outline of graphs and tables and then arrange these in logical order and build up the text around this. Consider to which extend you wish to discuss the results in this paragraph, or if you prefer to postpone it to the discussion paragraph. Avoid repetitions!

4.7 Discussion

Link and compare the results. Discuss experimental results in relation to the theoretical expectations and vice versa, if it is a theoretical project. A key element in the discussion is the comparison to previous studies. How do your results relate to the current state of knowledge? Take a critical approach - also to your own observations and results - but without being modest. Often, your studies may not provide new "Answers", but it is just as relevant to discuss the new "Questions", the project may give rise to.

4.8 Conclusion

Overall conclusion. In this (or in a separate) section, it may be relevant to discuss the future studies that should be made to come up with answers to the unresolved issues (see under “Discussion”). What is the next step to continue the scientific process?

4.9 Summary

A summary should be self-contained. It must describe the objective of the report, the methods applied and major findings. Remember that writing a summary in English is a requirement, and, if the report is written in English, a Danish summary is a natural section to include (but may be omitted if your Danish skills are very rudimentary).

4.10 Literature References

Correct and adequate use of references is a key element of the scientific process that is demonstrated in your bachelor report! As a rule, everything written in the report without references is considered your own original contributions to science. If you cite other people's ideas, observations or derivations and leave out referring to the source, it is scientific misconduct, and you risk being sanctioned depending on the extent. If you estimate that citing a somewhat longer theoretical derivation is important - if, e.g., the theoretical derivation is not considered assumed knowledge - it is not necessary to write the reference in every step. Instead, begin your paragraph with “In the derivation of the equations (nn) to (NN), the reference “XX” is followed”.

To keep track of your sources, you may want to use reference tools such as Endnote or BibTeX. References should be listed in the end of the report and must be complete with indications of authors, journal title, volume, page number, start to end, and publishing year. For books/monographs, you should also include the publisher and place of publication.

Check that you are consistent in terms of notation (and typography) in all references! A reference should only appear once in the list of references; you may of course cite this several places in the report. The references are listed either in consecutive order (the order that they are listed in the text) or in alphabetical order according to the first author's last name (if, in the text, you cite by using the author and the publishing year). All listed references must be referred to - either in the main text, in the footnotes or the figure captions.

4.11 Appendices

Any extra material may be included under Appendices. It should not be necessary to read the appendices in order to understand the main text! Appendices can be used to provide scientific documentation in terms of (examples of) specific measurements or to present (parts of) the numerical codes developed.

5. Figures

Figures are a key part of your report, and sometimes it may ease the organization of the writing process, if you consider which figures will be included in a specific section (see paragraph 4.6 above).

The figures must be easy to read; clear captions for figures and tables, symbols of appropriate sizes, easily recognizable colours, appropriate line widths, legible numbers and units on all axes! Make a printout of the figure in the size, it will have in the report, and check that it has the right dimensions. Use vector graphics to avoid pixilation - or make sure to use a suitably high resolution. Matlab users can use the “Export setup” function to generate a graph with the desired properties.

All figures must be numbered sequentially, and they must have a caption. Note that it is okay to copy-paste a figure from a reference. In this case, however, it must be evident to the reader that the figure is not made by you, and the reference must be cited in the caption. See clause 4.10 above.

6. Statistics and Uncertainties (experimental work)

In the report, you are expected to demonstrate that you know the methods for the calculation of statistics and uncertainties, which you have been introduced to during the course of your Bachelor’s degree programme. Make sure to enter your results with the appropriate number of significant digits according to the uncertainties.

7. Quality Assessment

Finish your report in due time to make a printout of the final PDF file in the proper size. Use another computer and printer than the one that you have used in the writing process. Read the printout at your leisure and check that everything looks as you had expected. Do the figures look right, with no pixilation or shadows?

References

1 https://studerende.au.dk/en/studies/subject-portals/physics/

2 https://kursuskatalog.au.dk/en?year=2020-2021

3 https://studerende.au.dk/en/studies/subject-portals/physics/bachelors-project-masters-thesis-and-other-projects/

4 https://studerende.au.dk/en/csu/