CONTENTS

1. INTRODUCTION

A thesis is a project or a research paper produced by a student to demonstrate that such a student is competent enough to engage in independent professional activity. The thesis is an essential part of the learning experience for students as it focuses on their ability to integrate knowledge acquired throughout courses into a concrete problem.

The project outcome can take two forms depending on the nature of the project's goals: system development (thesis type 1) or research-oriented investigation (thesis type 2).

If your thesis focuses on system development, the outcome will take the form of the design, implementation, test, and evaluation of a complete system. This type of thesis might be done based on an Industrial project. Intellectual property is generally agreed between the student, company, and university on a case by case basis. An agreement has to be signed to clarify what access rights the university has over the source code. In most cases, this agreement does not prevent the publication of a scientific article. The Center for Career Development is in charge of preparing the agreement validating the compatibility between University and Company. The agreement shall be signed before any research and development starts.

If your thesis focuses on a research-oriented investigation, the outcome will take the form of an analysis of the subject area, a synthesis of a specific conjecture or hypothesis, empirical validation of the proposed model, and critical appraisal of the empirical or theoretical results.

This document serves as guidelines to ensure the maximum quality of students' work within the allotted time. The thesis work will be developed incrementally: students will have a running prototype of the thesis by the end of the first academic term, and complete the thesis by the end of the academic year.

Lastly, it is essential to emphasize that during the thesis, students are expected to meet regularly with their supervisor and to act diligently on them.

2. PREPARING TO WRITE YOUR THESIS

2.1. General guidelines

First of all, you should open a list of potential topics. These topics will be suggested by the prospective thesis supervisors shortly after the start of the semester once you have selected your educational track. Students can also suggest their own research topics.

Then, you should choose topics of interest and organize a meeting with a potential supervisor. The goal of this meeting is to decide on the thesis topic, research questions, title, aims, objectives, and the general structure of the thesis project.

With your potential supervisors' help, you should develop a complete specification of the problem, listing objectives, requirements, and a work plan to develop. The specification should include your research question(s).

In general, your research should follow the steps below (see the flowchart).
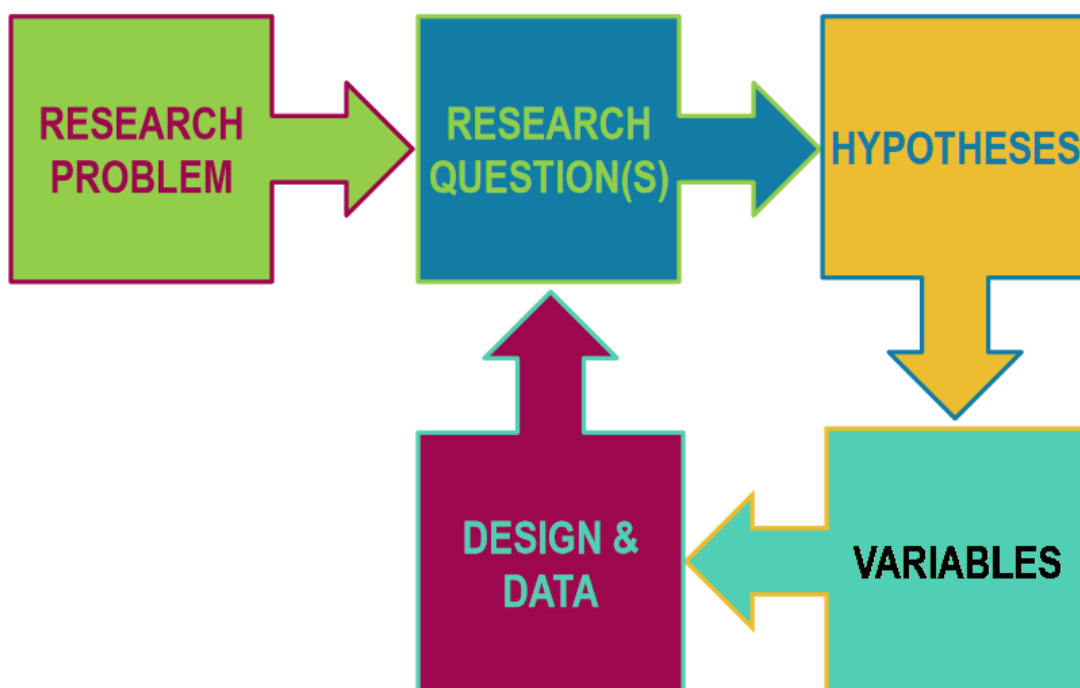
Adapted from: https://www.westga.edu/academics/research/vrc/assets/docs/FoundationalElementsOfResearch_HANDOUT.pdf

The subsections below will detail all the elements of the flow chart.

2.2. Research problem

2.2.1. What is a research problem?

A research problem is a specific gap, issue, difficulty, or controversy that you will target in your research. You might search for practical problems or theoretical problems.
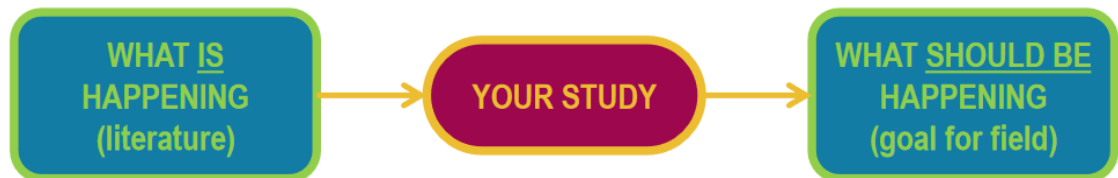
WHAT IS HAPPENING (literature) → YOUR STUDY → WHAT SHOULD BE HAPPENING (goal for field)

Adapted from: https://www.westga.edu/academics/research/vrc/assets/docs/FoundationalElementsOfResearch_HANDOUT.pdf

You need a well-defined research problem to keep your research focused and manageable, as well as to provide new and relevant insights.

Otherwise, you might be repeating what other researchers have already said, trying to say too much, or doing research without a clear purpose and justification.

2.2.2. Two steps to developing a research problem

Step 1: Locate a problem area

Read about your topic looking for under-researched aspects and areas of controversy. The role of your supervisor is crucial at this step. You may want to ask your supervisor for the directions of specific research problem areas.

Your goal is to find a gap that your research project can fill.

Step 2: Learn more about the problem

- Learn what is already known about your problem, and discover the exact areas that your research will focus on.

To help you clearly define your research problem, you can answer the following two groups of questions:

Context and background	Relevance and specificity
Who does the problem affect?	What time, place, and/or people will you concentrate on?
What research has already been done?	What aspects will you not be able to deal with?
Have any solutions been proposed?	What will be the outcomes of the unresolved problem?
Has the problem been an issue for a long time?	Who will benefit from solving the problem?
What are the current debates about the problem?	

You might want to answer the above questions in writing to clearly formulate your research problem.

2.3. Research questions

2.2.1. What is a research question?

Once you have clearly defined your research problem, you need to formulate one or more research questions.

A research question is what exactly you want to know and how that knowledge will help to solve the research problem.

You may develop one question or several of them. You may also produce one primary research question and several sub-questions for the same research problem.

Adapted from: https://research.com/research/how-to-write-a-research-question

2.2.2. Criteria of a good research question

Hulley *et al.* have introduced the "FINER" criteria to determine if your research question is good.

The FINER criteria are as follows:

F – Feasible
Your question is within your ability to investigate. You should be realistic about the scale of your research as well as your ability to collect data and complete the research with your skills and the resources available. Note that you also should have a method for answering the research question.

I – Interesting
The ideal research question is interesting not only to yourself but also to your peers and the research community in general.

N – Novel
Your research question should bring new insights to your field of study. The question may confirm or extend previous findings on the topic you are researching, for instance.

E – Ethical
Your research question and your subsequent study must be something that the appropriate authorities will approve.

R – Relevant
Your research question should be meaningful to the scientific community, people involved in your area of study, and to the public's interest.

Make sure that you have discussed all the FINER criteria with your supervisor.

2.2.3. How to formulate a research question?

You will phrase your question depending on your research aim (see the table below).

Your research aim	How to formulate a research question
To test and explain	What is the relationship between X and Y?
	What is the role of X in Y?
	What is the impact of X on Y?
	How does X influence Y?
	What are the causes of X?
To act and evaluate	What are the advantages and disadvantages of X?
	How effective is X?
	How can X be achieved?
	What are the most effective strategies to improve X?
	How can X be used in Y?
To explore and describe	What are the characteristics of X?
	How has X changed over time?
	What are the main factors in X?
	How does X experience Y?
	How has X dealt with Y?

Adapted from: https://www.scribbr.com/research-process/research-questions/

2.2.4. Frequent mistakes in formulating research questions

Incorrect	Correct	Comments
Has there been an increase in childhood obesity in the US in the past 10 years?	How have school intervention programs and parental education levels affected the rate of childhood obesity among 1st to 6th-grade students?	**Avoid the "yes" or "no" questions** — they do not provide enough scope for investigation and discussion. To answer the good question, the researcher must collect data, perform in-depth data analysis, and form an argument that leads to further discussion.
How does social media affect people's behavior?	What effect does the daily use of YouTube have on the attention span of children aged under 16?	**Avoid vague language and broad ideas.** A good research question should be specific and focused, and it should be answered through collecting data and analyzing them.
Is X or Y a better policy?	How effective are X and Y policies at reducing rates of Z?	**Avoid subjective words, such as *good, bad, better* and *worse*,** as these do not give clear criteria for answering the question. If your question is evaluating something, use terms with more measurable definitions.

Adapted from: https://research.com/research/how-to-write-a-research-question
https://www.scribbr.com/research-process/research-questions/

2.4. Hypotheses

2.4.1. What is a hypothesis?

A hypothesis is an answer to your research question that predicts what you will find in your research.

In Computer Science experimental research, you can typically phrase hypotheses in one of the following forms:

1. Technique/system X automates task A for the first time (*no one has done it before*).

2. Technique/system X automates task A better than each of its rivals, as compared by the following:
    a. ***Behavior***: X has a higher success rate or produces better quality than Y.
    b. ***Coverage***: X is applicable to a wider range of examples than Y.
    c. ***Efficiency***: X is faster or uses less space than Y.
    d. ***Dependability***: X is more reliable, safe or secure than its rivals.
    e. ***Maintainability***: X is easier to adapt and extend than its rivals.
    f. ***Usability***: Users find X easier to use than its rivals.

2.4.2. Elements of a hypothesis

Your hypothesis statements need to contain the following elements;
1. independent variable;
2. dependent variable;
3. population;
4. the relation between independent and dependent variables.

You can think of independent and dependent variables in terms of cause and effect: an independent variable is the *cause*, while a dependent variable is the *effect*.

In other words, an experimenter changes or manipulates an independent variable to measure the effect of this change on a dependent variable.

2.5. From a research problem to a hypothesis

Example:

1. Research problem	A student group has low attendance and numerous D-grades. However, certain students of the same group have higher grades.
2. Research question	How does students' attendance rate affect their grades?
3. Hypothesis	Students' attendance rate positively correlates with students' grades.
a. Independent variable	attendance rate
b. Dependent variable	grades
c. Population	students
d. Relation between independent and dependent variables	correlation

3. WRITING YOUR THESIS

This chapter shows the general guidelines for writing a thesis.

3.1 Sample thesis structures

Default thesis structure
- Introduction
- Literature Review
- Design and Methodology
- Implementation and Results
- Analysis and Discussion
- Conclusion
- Bibliography/References

IU thesis structures are recommended, not prescriptive. Therefore, the items above are not mandatory and should rather be used as a guideline for students and advisors. Some research supervisors will request to follow particular structures though. The final contents and structure of the thesis is subject to a student themselves and their supervisor.

In general, you can choose between the following 2 recommended structures:
- system development;
- research-based.

'System development' in a broader sense includes system deployment, testing/analysis of a system (reverse engineering, testing, numerical analysis, etc.), technology applications and other types of professional activities.

See several examples of thesis structures below, with sample content items.

Alternative contents #1 (system-development thesis)
• Introduction (motivation, literature review, problem statement, assumptions, background)
• Theoretical Part / Benchmarking
• Evaluation / Experimental Study (experimental setup, methodology)
• Conclusion and Discussion

Alternative contents #2 (research-based thesis)
• Introduction
• Problem and Discussion
• Methods and Results
• Concluding Discussion

• For thesis type 1, students should describe:
  ● the functionality of the system to be designed;
  ● the parameters affecting the performance of the system;
  ● the limitations and restrictions of the system to be designed.

• For thesis type 2, students should describe:
  ● the goals of the investigation to be carried out in the project;
  ● the criteria or metrics to be used to assess the outcome of the investigation.

The thesis template is available at
https://tfs.university.innopolis.ru/tfs/Edu/_git/doe-docs?path=%2Fthesis_template&version=G Bmaster

3.2 General guidelines

Write your thesis in English and have a recommended length of 40+ pages.

These 40+ pages include the following:
- Table of contents
- Thesis chapters

These 40+ pages DO NOT include the following:
- Title page
- Appendices
- Reference list

When writing your thesis, please follow the conventions of the effective academic writing style.

Avoid the **stylistic mistakes** provided in the Academic Style Reminder at the following link:
https://innopolis.university/en/writinghubhome/academicstylereminder/

3.3 Title, abstract, acknowledgments, table of contents

Study the thesis template. If you have any enhancements, which can be useful for others, you can make a pull request.

3.3.1. Title

Your title has to be concise, informative and readily searchable.

In short, this part should answer the following **general question**:

- **What is your thesis about?**

When writing your title, follow these rules:

1. Capitalize every noun, verb, adjective, adverb or subordinating conjunction (*If, Because, That, Which*).
2. Use lower-case letters for any other part of speech unless it starts the title.
3. Capitalize a preposition if it consists of more than three letters (*Before, From, Through, With, Versus, Among, Under, Between, Without*). Otherwise, go with lower-case letters.

3.3.2. Abstract

3.3.2.1. Content

An abstract is a summary of the whole thesis. Generally speaking, you should write your abstract after you have drafted the thesis.

Your abstract should consist of one paragraph.

Do not discuss any information that has not been covered in the thesis .

Remember that a good abstract makes sense on its own, without the need to read the whole thesis.

In short, this part should answer the following **general question**:
- **What is your thesis about in a nutshell?**

You will need to submit your abstract in English and in Russian. The maximum length of your abstract is 400 words.

3.3.2.2. Structure

However, make sure that your abstract contains the following:

- the research gap;
- the limitations of previous research;
- the novelty of your research;
- the research objective;
- the the research method;
- the research results;
- the result implications and/or discussions.

The structural components are as follows:

- the same as in the thesis;
- sequenced in the same way as in the thesis.

3.3.2.3. What English tenses to use?

You can follow the following two approaches when using English tenses in your abstract:
1. use the same tenses you used in the corresponding chapter of your thesis;
2. use the present tense only.

3.4 Introduction

3.4.1. Content

The Introduction chapter should clarify the overall purpose of the work and explain the novelty it brings.

In short, this chapter should answer the following **general question**:
- **Why did you do it?**

You chapter should answer the following **specific questions**:

- What is the problem?
- Why is the problem important?
- What is known about the problem;
- What is not known about the problem (research gap)?
- Why does this problem have to be further researched?
- What are your hypotheses or solutions for the problems?
- What are your research questions, purpose or objectives?

Though Introduction comes first in your thesis, researchers generally prefer this chapter to be the last to write.

Make sure that your Introduction is concise.

3.4.2. Structure

Introduction element	How to write
Background	Show what is already known in the area. Provide broad and specific information, as well as previous research in the area. Discuss the problem and its importance.
Novelty/Research Gap/Unknown	Explain what was wrong with the previous work in the area. Describe any unknown factors in the area.
Questions/Problems/Purpose of study	Explain how your thesis contributes to the research problem.
Experimental/Design Approach*	Explain what approach is taken towards this contribution.
Results and Conclusions*	Provide main results and findings related to the study purpose.
Significance/Implications*	Explain how your findings are important.
Paper Structure Outline*	Briefly preview the contents of each chapter.

* These elements are optional but highly advisable since they will draw readers in, especially Results and Conclusions.

3.4.3. What phrases to use?

Use the "Introducing work" section of the Academic Phrasebank to help you verbalize your thoughts.

The link:

https://www.phrasebank.manchester.ac.uk/introducing-work/

3.4.3. What English tenses to use?

Use the Present Simple to describe the aims of the paper.

You can sometimes use the Present Perfect Simple or Present Perfect Continuous to describe the background to the problem.
Example
- *Researchers have generally ignored the problem of X.*
- *The Interest in Y has been increasing*.

To highlight the research results, you use the Past Simple:
- *By contrast, the research found that...*

To discuss the result implications of the results, use the Present Simple:
- *These results suggest that the theory of Z needs to be reconsidered.*

To provide an outline for your paper, use the Present Simple:
- *Chapter 3 sets out… .*

If you are writing a math thesis, you can use the Future Simple to introduce a proof of a theorem, etc.:
- *It will be demonstrated that…*

However, note that such a use is rather an exception and not a standard.

3.5 Literature Review and Related Work

3.5.1. Content

In this chapter, you should do the following:
- show that you have real expertise in your research area;
- show respect to the previous researchers;
- show how your work relates to current debates in your research area
- choose methods for your experiment/project and justify the choice.

For this, you may consult books, research journals, conference proceedings, handbooks, and even online courses.

In short, this chapter should answer the following **general question**:
- **What is the state of knowledge on the topic?**

You chapter should answer the following **specific questions**:

- What is the relevant prior work?
- How are these sources relevant to your research question?
- Where can I find it? (citations are important)
- Has anyone attempted your approach previously?
- Where is that work reported?
- Why should it be done differently?
- What is the outline of your way?
- Which research methods do you need to mention?
- How can you classify these methods?
- How can you evaluate these methods?
- Which research metrics will you need to mention?
- How can you classify these metrics?

3.5.2. Structure

Your Literature Review has to consist of the following:
1. **Preamble**
   - provides orientation for your readers.
2. **Body**
   - classifies and evaluates previous solutions and methods.
3. **Conclusion**
   - summarizes and justifies the choice of the current research method.

3.5.3. What phrases to use?

Use the "Referring to sources" section of the Academic Phrasebank to help you verbalize your thoughts.
The link:
https://www.phrasebank.manchester.ac.uk/referring-to-sources/

3.5.4. What English tenses to use?

For your Literature Review, use the following three tenses: the Past Simple, the Present Simple, and the Present Perfect Simple.

Use the Past Simple:

- when you refer to past research:
  - *Kickfeis [23] found that…*

- when the cited author is already dead:
  - *Sigurdarsson [34] infamously claimed that…*

Use the Present Simple:

- when you refer to recent research:
  - *Foelicker [3] shows that…*

- when you show that the author still supports the cited ideas:
  - *Eshol [45] persistently argues that…*

Use the Present Perfect Simple:

- when you refer to the research that was carried out in the past, but is still relevant:
  - *Tricksters [1] has demonstrated that, under the right conditions, the X effect can manifest itself."*

- when you use *ever, never, just, already, yet, so far, up to now, recently, since, for (to show duration)*:
  - *So far, no evidence has been found that…*
  - *Since 2020, the discrepancy has become increasingly clear.*

3.6 Design and Methodology

3.6.1. Content

In this chapter, you should describe the general structure of your research: methods, approaches, or processes followed during the study. Link your methodology back to the aims of the thesis and the literature to explain why you are using such methods.

In case of system development, you should describe the design of the system: describe each component and how they will interact with each other. You should also describe the experiments carried out. Your design and solutions should be simple, effective, robust, and consistent with industrial standards.

3.6.2. Structure

In short, this chapter should answer the following **general question**:

- **How did you do it?**" and "**Why did you do it that way?**

You chapter should answer the following **specific questions**:

- Why did you use this technology/method?
- How does the theory relate to your implementation?
- What are your underlying assumptions?
- What did you neglect, and what simplifications have you made?
- What tools and methods did you use?
- Why use these tools and methods?

3.6.3. What phrases to use?

Use the "Describing methods" section of the Academic Phrasebank to help you verbalize your thoughts.

The link:
https://www.phrasebank.manchester.ac.uk/describing-methods/

3.6.4. What English tenses to use?

Use the Past Simple to write this chapter since the Design and Methodology describes completed actions in the past.

If you compare your methods with the methods employed by other researchers, use the same tenses as you used in your Literature Review.

For math and computational papers involving demonstrations and proofs, the Design and Methodology chapter can be replaced by the Analysis. In this case, use the Present Simple:
- *Rearranging the equation terms gives the following relation between y and x.*

3.7 Implementation and Results

3.7.1. Content

In this chapter, you should detail the implementation performed, as well as the results of applying the system implementation to a case study or an experiment undertaken.

Describe the following:
• For thesis type 1:
- Test suites implemented and documented.
- Faults also documented and cataloged.
- The system performance compared to those other systems
- described in Section 3.5 or with benchmark metrics.

• For thesis type 2:
- Results presented in a manner that makes explicit their relationship to the research question.
- Certain estimate of error or reliability, and a comparison to those other systems described in Section 3.5 or with benchmark metrics.

3.7.2. Structure

In short, this chapter should answer the following **general question**:

- **What did you find? or How did it work?**

You chapter should answer the following **specific questions**:
- Did you build it?
- How can you test it?
- How did you test it?
- Why did you test it this way?

3.7.3. What phrases to use?

Use the "Reporting results" section of the Academic Phrasebank to help you verbalize your thoughts.

The link:
https://www.phrasebank.manchester.ac.uk/reporting-results/

3.7.4. What English tenses to use?

Use only the Past Simple to write this chapter since you obtained your results in the past.

For math and computational papers involving demonstrations and proofs, the results can be specified through the Present Simple:

- *This result holds good for all real values of x.*

3.8 Analysis and Discussion

3.8.1. Content

This chapter should analyze the findings from the previous chapter, as well as limitations, and the implications for future research and applications. You should discuss if the findings are accurate and relevant, as well as compare them with the other researchers' results.

Please, note that Analysis and Discussion should not recapitulate the findings from the previous chapter, but instead interpret and discuss them. Make sure that your interpretation is related to your research question.

Highlight both correlations and lack of correlation between variables. Should some findings be unclear, do not leave out the discussion of such results. You should acknowledge the limitations of your study, and any potential flaws.

Your discussion should highlight the ways in which the results agree and contract with the existing research. Furthermore, highlight any new understanding arising from the research, i.e. its academic significance.

Note that this chapter should go beyond current research. Demonstrate how well the findings of the research can be applied to the contexts outside of your research, i.e. external validity of the results. Discuss whether the results have any implications for public policy, applications in other fields. Suggest possible directions for future research.

In short, this chapter should answer the following **general question**:
- **What does it mean and so what?**

You chapter should answer the following **specific questions**:

- Are the results satisfactory?
- How do you define success in your thesis work?
- Why should you (not) test it more?
- What compensations had to be made to interpret the results?
- Why did you succeed/fail?
- How would you explain the results that you obtained?
- Did you achieve your objectives?
- What are the limitations of your research?
- What are the implications for future research and application?

3.8.2. Structure

How to write
1. Interpret key findings related to this purpose
2. Explain how these key findings are supported by relevant results
3. Compare your findings with the findings of previous research
4. Explain discrepancies if any
5. Describe the limitations of your research
6. Describe and interpret unexpected findings if any
7. Show how your findings can be applied outside of your research, if possible

3.8.3. What phrases to use?

Use the "Discussing findings" section of the Academic Phrasebank to help you verbalize your thoughts.

The link:
https://www.phrasebank.manchester.ac.uk/discussing-findings/

3.8.4. What English tenses to use?

Use the Present Simple to write this chapter since you are discussing what the results mean at present.

If you need to cite other research, use the same guidelines as discussed in Section 3.5.4 of this document.

Frequently, you will have to use modals of possibility and probability:
- *This figure **might** mean that…*
- *Therefore, future procedures **could** be changed so as to…*
- *These results **may** indicate…*

3.9 Conclusion

3.9.1. Conclusion content

This chapter is a short account of the results of your work, emphasizing mainly what is new. Align the conclusion to the Introduction that described the problem or a research question.

In this chapter, you should state the consequences of the achieved results. You should also mention whether the results are satisfactory, and how they can be improved. What is more, you should mention the limitations of the work and suggest what further work might be done. Make a synthesis of the contributions and impact of your work and recommendations.

In short, your Conclusion should answer the following **general question**:

- **What are your major findings and their significance?**

3.9.2. Conclusion Structure

How to write
1. Restate your research purpose or research question.
2. Summarize your main findings.
3. Describe the significance of your research.
4. Describe how your research contributes to the current state of knowledge in your research domain.
5. List the limitations of your research.
6. Suggest future research focus.

3.9.3. What phrases to use?

Use the "Writing conclusions" section of the Academic Phrasebank to help you verbalize your thoughts.

The link:
https://www.phrasebank.manchester.ac.uk/writing-conclusions/

3.9.4. What English tenses to use?

Use the Present Perfect Simple to look back at the paper:
- *This paper has demonstrated that…*
- *The thesis has argued that…*

Use the Past Simple to refer to the methods and results of the research:
- *The suggested platform design was more effective as compared to earlier solutions.*
- *The object-oriented approach was employed in developing the software.*
- *This experiment proved that…*

Use the Present Simple to show the significance of your research:
- *These results open up a promising new avenue for research into X…*
- *The new sources examined make clear that…*

You can sometimes use the modals of possibility and probability to demonstrate the significance of your research:
- *The design **could** revolutionize the …*
- *Apparently, X **may** be employed to…*
- *This research **might** indicate that…*

If you need to compare your results with the other researchers' results, use the same guidelines as discussed in Section 3.5.4 of this document.

Discuss the research implications for the future with the Present Simple, the Future Simple, or modals of possibility:
- *Meeting higher expectations remains significant, yet challenging due to rising costs.*
- *Developing a proper intrusion detection protocol will reveal the professionalism of the project team.*
- *The Cybersecurity and Infrastructure Security Agency (CISA) could be facing a period of radical upheaval.*

3.10 Bibliography/References

The thesis references should follow the IEEE style (see the Latex template).

Set your reference numbers flush left to form a column of their own and hang out beyond the body of the reference.

Enclose your reference number into square brackets.

No plagiarism is acceptable. The graduation thesis will be checked by an anti-plagiarism system. If the thesis authenticity is below 70%, such a thesis shall be returned for revision.

Include any source you use in your thesis into your reference list.

When in doubt, refer to the following diagram:
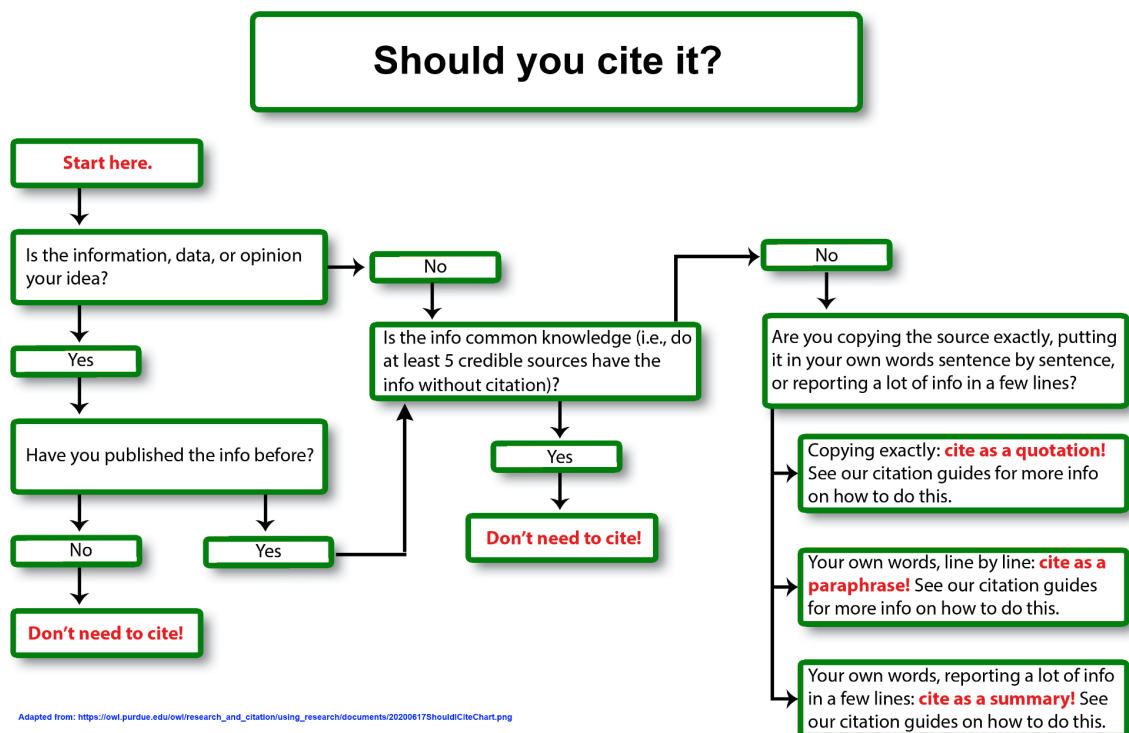
Furthermore, provide an in-text citation for any source you mention.

Include page numbers in your in-text citations when you are using a direct quotation.

Never use Russian-style quotation marks («… »; „ … ").

Frequent reference mistakes

Error	Correction
… in reference [1] …	… in [1] …
In Smith [1]	In [1], …
Smith, Brown and Jones [5] claim that...	Smith *et al.* [5] claim that...
According to Dick and John [3], ...	According to [3], ...

Check that the cited author's name in the text has the same spelling as the reference list.

Avoid referring to the following non-credible sources:
- Wikipedia;
- non-peer-reviewed sites;
- non-academic manuscripts;
- blogs or social networks.

For more information refer to the ***IEEE Reference Guide*** at:

https://journals.ieeeauthorcenter.ieee.org/wp-content/uploads/sites/7/IEEE_Reference_Guide.pdf

3.11. Appendixes

Use an Appendix to provide additional information in your thesis.

An Appendix can contain any information that is not immediately required to make your point. Using an Appendix helps to keep your thesis text focused and concise.

Still, note that readers must be able to understand your thesis without the appendices. The Appendixes only serve to provide additional information.

Label all figures and tables in the Appendixes in consecutive order with the other figures in your thesis.

Refer to the Appendix in text as "given in the Appendix."

Note that the plural of Appendix is **Appendixes**.

3.12. Dealing with visuals

3.12.1. General rules

1. Place figures and tables as close to their first mention as possible, but preferably after the mention.
2. Make sure that figures and tables progress on pages vertically, not horizontally.
3. Make sure that your table or figure is understandable from its caption alone, without referring to the text.
4. Use your visuals to make your thesis clearer. Never use a visual just for the sake of it.
5. Always interpret your visuals since they do not speak for themselves. Tell your readers how to understand your visuals.

3.12.2. Major visuals and when to use them

Type of visuals	When to use
Photographs	To show actual appearance
Block diagrams	To show relationship of components in a system or a process
Table	To present the exact numbers
Line graph	To show dynamic comparison, usually over time
Scatter plot	To show correlation
Bar graph	To compare data when no evidence of continuum is given
Pie chart	To give percentage or to compare parts of a whole
Box plot	To display differences between datasets, showing central value, variability, and range

3.12.3. Figures

Follow these rules:

1. Place your caption below the figure.
2. Always abbreviate the word "Figure" to "Fig."
3. Place an em-space after "Fig.".
4. Number your figures continuously throughout the document.
5. Place a period after the figure number.
6. Always capitalize the first word of the figure caption.
7. Use no articles at the beginning of the caption.
8. If your figure consists of several parts, use (a), (b), (c), etc. to label the parts. Capitalize the beginning of every part. Make sure that (a), (b), (c), etc. precedes the labeled part.
9. Place a period at the end of the figure caption.
10. Refer to your figures using Present Simple.
11. Label everything on your figure and provide a figure legend.
12. Explain all symbols and abbreviations in your figure.
13. When writing units on axis labels in graphs, write your units within parenthesis, for example: *Voltage (V)* or *Time spent on a programming task (hours)*.

Example
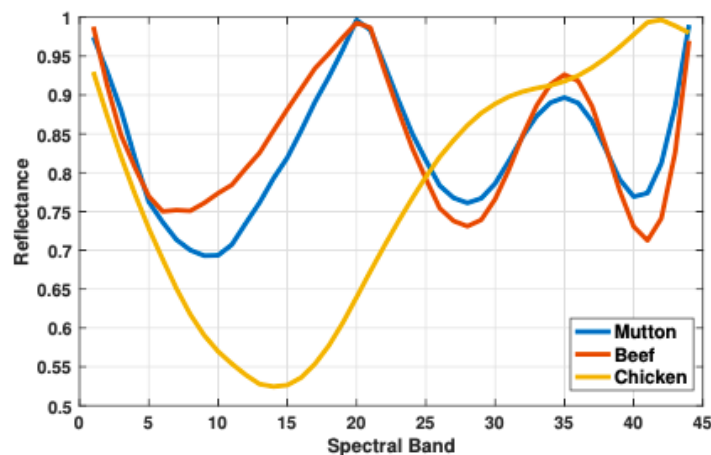

Fig. 6. Reduced spectrum of minced meat, representing Myoglobin pigments (Mb) pigments information for each minced meat types.

3.12.4. Tables

Follow these rules:

1. Place your caption above the table.
2. Use the label TABLE and Roman numerals.
3. Center the table caption directly below the TABLE + a Roman numeral.
4. Try to make your table caption into an inverted pyramid.
5. Capitalize every noun, verb, adjective, adverb or subordinating conjunction (*If, Because, That, Which*) in the table caption. If a preposition consists of more than three letters, capitalize such prepositions as well (*Before, From, Through, With, Versus, Among, Under, Between, Without*).
6. If your table consists of several parts, use (a), (b), (c), etc. to label the parts. Make sure that (a), (b), (c), etc. precedes the labeled part.
7. Use no period at the end of the table caption.

Example

<div align="center">

TABLE I
Some Totally Random Data Used to Illustrate
the Principle of Providing Tables
as per IEEE

</div>

Some random metrics	Some random data			
Metric 1	1	7,900	566	654
Metric 2	34	045	3	789
Metric 3	6	56	4	-
Metric 4	45	45	564	4

IMPORTANT!

Note that tables are generally good for showing exact values. If you want to show trends, avoid tables and use graphs or charts.

3.12.5. Equations and formulae

Follow these rules:
1. Present your formulae, equations, and proofs as a part of text.
2. Number your equations continuously, from the beginning of the thesis to its end.
3. Place your equation number inside brackets.
4. Place your equations flush right on line with the last line of an equation.
5. To refer to an equation, use the word "Equation" in the beginning of a sentence; otherwise, just use the number [e.g., in (1)].
6. Equations which conclude a sentence should end with a period.
7. Delete commas appearing at the ends of equations unless these commas are critical to the sentence punctuation.

Example

3.3.2. Model Evaluation

To evaluate the performance of the proposed 3D-DL model, several statistical tests have been analyzed, including overall accuracy, F1-score, precision, and Recall through the following equations;

$$OA = \frac{1}{M} \sum_{k=1}^{M} True^P{}_k \tag{5}$$

$$Precision = \frac{1}{M} \sum_{k=1}^{M} \frac{True^P{}_k}{True^P{}_k + False^P{}_k} \tag{6}$$

$$Recall = \frac{1}{M} \sum_{k=1}^{M} \frac{True^P{}_k}{True^P{}_k + False^N{}_k} \tag{7}$$

$$F1 - Score = \frac{2 \times (Recall \times Precision)}{(Recall + Precision)} \tag{8}$$

The values used in the above equations are computed through the confusion matrix. Where $True^P$ and $False^P$ represents the true and false positive, $False^N$ represents the false-negative and M represents the number of samples. The statistical tests are presented in Table 2, where one can easily observe the

Image source: Hamail A., Ahmad M., Mazzara M., Sohaib A., Hyperspectral Imaging for Minced Meat Classification Using Nonlinear Deep Features, November 2020
Applied Sciences 10(21):7783

3.13. Dealing with digits and numbers

Follow these rules:
1. Never start your sentence with a digit.
2. Spell out numbers below 11 (*seven experiments*, not *7 experiments*).
3. Use digits for numbers with units (*33 min*., not *thirty three min*.).
4. Use digits for numbers over 10 (*700 devices,* not *seven hundred devices*)
5. Abbreviate units when they are used with quantities (*33 min., not 33 minutes*).
6. Spell out units used in text without quantities (e.g., "*where the noise is given in decibels*").

3.14. Dealing with lists

3.14.1. General labeling order:

1) Item 1
   a) Sub-item 1
   b) Sub-item 2
   c) Sub-item 3
      i) Sub-sub-item1
      ii) Sub-sub-item 2
      iii) Sub-sub-item 3
2) Item 2
   a) Sub-item 1
   b) Sub-item 2
   c) Sub-item 3
      i) Sub-sub-item1
      ii) Sub-sub-item 2
      iii) Sub-sub-item 3
3) Item 3
   a) Sub-item 1
   b) Sub-item 2
   c) Sub-item 3
      i) Sub-sub-item1
      ii) Sub-sub-item 2
      iii) Sub-sub-item 3

3.14.2. Run-In Lists

Use these lists if the lists are three items or less.
Alternatively, use run-in lists if the list items are not mentioned further in the thesis text

Follow these rules:
- Introduce run-in lists with a colon.
- Separate list items with semicolons.
- Make sure that the list items have parallel grammatical construction.

Example:
The carrier–phonon interaction matrices are given by: 1) polar optical phonons; 2) deformation potential optical phonons; and 3) piezoelectric acoustic phonons.

3.14.3. Displayed Lists

Incomplete-sentence items

Use these lists if the lists have three items or more. What is more, use incomplete-sentence displayed lists if the list items are further mentioned in the thesis text.

Follow these rules:
- Introduce the item with a colon.
- Number the items.
- Begin the entry with a lowercase letter.
- Set block paragraph style.
- Use semicolons between items.
- Use a period at the end of the list.

Example 1:

This operating scenario provides all of the contributors necessary to configure a resonant power distribution system:
1) implementation of capacitor power factor correction on the power line;
2) presence of nonlinear load;
3) tuning of the power line by the load adjustments to a frequency present in the nonlinear generator.

You may also format incomplete-sentence items as full-sentence items.

Example 2:

The three problems are related in the following sense:
1) Additional cost constraint;
2) Relaxation of the constraints is permitted;
3) Limited budget optimization is a general optimization problem.

Full-sentence items

Follow these rules:
- Introduce full-sentence items with "that" or other words taking object.
- End the introductory part with a period.
- Number all items.
- Start each item with a capital letter.
- End each item with a period.

Example:

The synthesis is performed in three major steps.
1) Geometry is generated for the selected module variants.
2) Shape variants using different fold counts for resistors are generated for each module.
3) Routing and postprocessing complete the final layout.

3.14.4. Where-Lists

Where-lists define variables in equations.

These lists are characterized by incomplete sentences.

Follow these rules:
- Indent the left-hand side.
- Lowercase the first letter on the right-hand side.
- End each item with a semicolon, but for the last item that ends with a period.
- Use these rules for the lists that are at least three items long; if fewer than three items, the list is generally run in the paragraph form.

Example:

where

$$\Delta \upsilon_S \quad = \Delta V_S \cos (\omega' t + \phi');$$

ΔV_S amplitude of supply voltage flicker;

ω' angular frequency of supply voltage flicker;

V_{Sf} supply voltage amplitude;

ω supply angular frequency.

4. DEFENDING YOUR THESIS

4.1 Formal criteria to be admitted to thesis defense

You must submit the following documents to the Department of Education office to be admitted to the graduation thesis defense:

• a bound thesis, signed by the supervisor on the title page, drawn up following
the requirements doc;
• a thesis annotation in Russian is on 10-15 pages doc;
• a thesis and a thesis abstract in soft copy (pdf with a text layer)
uploaded to Moodle;
• the supervisor's review signed by the supervisor doc;
• assessment done by an external expert (for masters only);
• the thesis presentation slides and handouts (if applicable);
• the grading form final thesis assessment.

4.2 Presentation

In addition to submitting the thesis, you will need to defend your thesis in front of the Expert Committee.

The thesis defense shall be held in English.
You will have 10 minutes only for the presentation. The presentation will be followed by a 10-minute question-and-answer session and a reading of the reviews.

The university shall set up a pre-defense presentation for you. The supervisors arrange the presentation's schedule and location. They might invite other IU Faculty to attend the pre-defense presentation.

The presentation should focus on the following:
- the problem in the thesis;
- the research questions;
- the work performed;
- the discoveries;
- the lessons learned,
- the recommendations.

The recommended structure of the presentation is as follows.
- General context.
- Open problem you addressed – research questions.
- Literature review and background.
- Your proposed solution to the problem – design and methodologies.
- Implementation and experiments.
- Results and discussion.
- Conclusions – contribution, impact, future work.

Your first presentation slide must specify your full name, thesis title, and your supervisor's full name.

You will have to convert your presentation to .pdf and send the file to education@innopolis.ru one or two days prior to the defense date.

You can choose any appropriate presentation slide design.

4.3 Assessment Criteria

For thesis type 1

• Does the student show that the design meets the requirements & specifications?
• Has a theoretical model been used or developed?
• Has a formal design methodology been adopted and, if so, properly used?
• Is the design well structured (e.g., is it hierarchical, are there well-identified interfaces, and is there a functional specification for each sub-system)?
• Is the design of the software or hardware fully implemented?
• Is the implementation modular?
• Is the final system of high quality (i.e., elegant or robust implementation consistent with industrial standards)?

For thesis type 2

• Are all the factors, empirical or theoretical, affecting the investigation analyzed and coherently summarized?
• Has a theoretical model been used or developed?
• Is a clear research question in the form of an explicit conjecture or hypothesis formulated and discussed?
• Are appropriate validation criteria identified and described?
• Have appropriate studies been conducted sufficiently well to address the research question (by simulation or other means)?
• Are the empirical tests well designed with clearly defined parameters and measurable outcomes?
• Are the empirical tests sufficient to arrive at a convincing conclusion or answer to the research question?

Organization & Clarity

• Is the abstract representative of the content of the report?
• Is there evidence that the student has read a representative amount of relevant material?
• Is this material properly cited?
• Is the report logical in its development of the material?
• Are grammar and spelling generally correct?
• Is the phraseology clear and concise?

Technical Content

• Does the student demonstrate mastery of the domain?
• Is the student's synthesis of the relevant material compelling?
• Has the student explained all the issues in his or her own words or recycled a significant amount of the text from other sources?

Conclusions and Future Work

• Are conclusions well written?
• Are the student's conclusions or insights significant?
• Has he or she presented an objective and thorough appraisal of his or her achievements?
• Does the student make clear what he or she has learned from the project?
• Does he or she present ideas on future work related to his or her project?
• Does he or she understand the relevance and importance of the work presented in the Thesis?

Presentation Delivery

• Has the student covered all of the relevant issues?
• Was the presentation clear and concise?
• Was the student confident in his or her subject matter?
• Did he or she make the subject matter interesting?
• Did he or she answer questions well?

4.4 Expert Committee

The Committee is headed by an external professor and includes professors from Innopolis University, as well as industry representatives.
The grades from the experts will be announced on the same day after the panel.