Guidelines for Evaluation of Master Project

Detailed version, July 2016, adjusted October 2017

1 The learning goals of a master project

At the end of a master project, the student is able to

1. Study relevant literature and gain in-depth knowledge in a certain mathematical topic;

2. Conduct research in the field of mathematical sciences and report on it in a manner that meets customary standards of the discipline;

3. Work together on a research team (e.g., in a hierarchical team of supervisor and junior member(s), together with peers or as a trainee in a company's research team or unit);

4. Communicate conclusions both written and orally as well as the underlying knowledge, grounds and considerations to various audiences in English (e.g. the research team, fellow researchers in the same area and master students in the same general area of mathematics);

5. Judge and evaluate mathematical research and publications;

6. Independently perform literature searches;

7. Enroll in a Ph.D. programme in mathematics or begin a career as a professional mathematician.

The final mark for a master project is built out of three marks which measure how well the student performed at achieving the learning goals.

	learning goals	percentage of average mark
Process	1 to 7	30%
Results	2 and 4	25%
Thesis	1,2 and 4	25%
Defence	1,2, 3 and 4	20%

The average mark is the weighted average of the four marks for process, results thesis and defence. The final mark is the minimum of the average mark and the avarage mark for thesis and results. Accordingly, in order for the student to pass, both the average mark for the results and thesis and the average mark of all topics should be at least six.

The **process** refers to everything that happened related to the project from the beginning up to (but not inclusive) the final product: thesis and defence. Here the student is judged on how much they learnt, how quickly they learnt, their ability to take up information at meetings, the depth of the mathematics learnt, quality of presentations during meetings and/or seminars.

The **results** refers to the results presented in the thesis, which represents the results of an area of focus of the project.

The **thesis** refers to the final piece of written work handed in at the end of the project.

The **defence** refers to the official oral presentation related to the thesis. It consists of 50 minutes of exposition followed by 10 minutes of questions by the audience. The target audience should be master students in the same general area, e.g., geometry, analysis, numerical analysis or stochastics.

A student should only defend a thesis if the supervisor believes that the process and the thesis work done thus far indicate a passing grade and gives his approval for the defence to take place.

Next, for each of the three items above we describe attributes that should correspond to different marks.

To decide for a grade it should suffice to select the bullets that best describe relevant aspects of the thesis. The chosen mark should fit the selected bullets in optimal fashion. The bullets may not always indicate the most accurate description. If so, they may still be helpful in suggesting an appropriate analogous description.

Hopefully the given criteria will help to standardise the final marks across different supervisors and give students a clear indication of what is expected of them.

2 The process

Below are *descriptions of the student* that should fit the different possible marks.

mark	description of the student

10 Exceptional	• Diligent, efficient, mature, independent (both searching and reading papers);
	• Showed exceptional ability in
	  a) **solving an** *interesting* **and** *very relevant* **open problem**;
	  b) **solving a problem** *of importance for a company*, e.g. resulting in product or patent;
	• Outstanding communications skills at meetings and seminars;
	• Wrote a thesis with minimal intervention from the supervisor;
	• Mastered the mathematical theory around the contents of their thesis;
	• Enriching experience also for the supervisor.

9 Excellent	• Diligent, efficient, mature, independent (both searching and reading papers);
	• a) Made an advance on a *relevant* open problem or
	  b) Read, understood and presented very important mathematical achievements or
	  c) Made an advance on a problem important for a company
	• Outstanding communications skills at meetings and seminars;
	• Wrote a thesis with minimal intervention from the supervisor;
	• Mastered the mathematical theory around the contents of their thesis;
	• Enriching experience also for the supervisor.

8.5 Very good	• Diligent, efficient, mature, independent (both searching and reading papers); • Read, understood and presented very important mathematical achievements; • In case of an internship, addressed a novel problem for a company. • Very good communications skills at meetings and seminars; • Wrote a thesis with little intervention from the supervisor, e.g., draft(s) handed-in had a number of typos or were wordy. These problems were swiftly corrected once pointed out; • Mastered the mathematical theory around the contents of their thesis; • Somewhat enriching experience also for the supervisor.
8 Good	• Diligent, somewhat independent (both searching and reading papers); • Read, understood and presented very important mathematical achievements; • In case of an internship, addressed a novel problem for a company. • Good communications skills at meetings and seminars; • Wrote a thesis without much intervention from the supervisor, e.g., draft(s) handed-in had a number of typos or were wordy or lacked structure or contained minor mathematical mistakes. These problems were swiftly corrected once pointed out; • Learned well the mathematical theory contained in the thesis.
7 Reasonable	• Somewhat independent (both searching and reading papers); • Read important mathematical achievements but needed tutoring from the supervisor to deal with parts of the theory; • In case of an internship, addressed a novel problem for a company, but needed tutoring. • Reasonable communications skills at meetings and seminars; • Needed intervention from the supervisor to write a thesis, e.g., drafts handed-in had several typos or were wordy or lacked structure or contained mathematical mistakes. These problems were corrected after some interactions; • Learned reasonably well the mathematical theory contained in the thesis.

mark	description of the student
6 Sufficient	• Lacked independence (both searching and reading papers); • In case of an internship, addressed a novel problem for a company, but needed tutoring to be able to do so. • Needed tutoring from the supervisor to deal with parts of the theory; • Subpar communications skills at meetings and seminars; • Needed severe intervention from the supervisor to write a thesis, e.g., drafts handed-in had several typos, were wordy, lacked structure or contained mathematical mistakes. Some of these problems were corrected after a few interactions; • Learned the mathematical theory in study at a sufficient depth;
< 6 Insufficient	• Unmotivated or unfocused and lacked independence (both searching and reading papers); • Frequently needed tutoring from the supervisor to deal with parts of the theory; • In case of an internship, failed to address problems of some novelty, in spite of tutoring. • Poor communications skills at meetings and seminars; • Needed severe intervention from the supervisor to write a thesis, e.g., drafts handed-in had several typos or were wordy or lacked structure or contained serious mathematical mistakes. Some of these problems were never fully corrected; • Failed to learn in the appropriate depth the mathematical theory studied;

Further thoughts.

- Marks above 9 are only given to relevant original research. The difference between a 10 and a 9.5 is the level of the scientific achievement.

- The mark 9 can also be awarded to non-original research. For the marks from 9 to 10 we require the overall experience itself (also for the supervisor) to be excellent.

- The difference between a 9 and an 8.5 is that for the latter the overall experience was very good, but not excellent, the thesis needed more than an epsilon input from the supervisor to reach its final form.

- The difference between an 8.5 and an 8 is that for the latter there may have been an occasional struggle with simple math, the student managed to do little or nothing beyond the original scope of the project (assuming it was not an overly ambitious project to start with), the quality of the first draft was a step away from ideal.

- The difference between an 8 and a 7 is that for the latter there may have been a struggle with simple math, some meetings became more tutorials from the supervisor than reports from the student, the student did not truly manage to cover the original scope of the project, the quality of the first draft was far from ideal and it remained not ideal after the first interaction with the supervisor.

- The difference between a 7 and a 6 is that for the latter several meetings became tutorials by the supervisor. Furthermore, the student did not truly manage to cover the original scope of the project which had then to be re-shaped to fit the student's abilities, the quality of the first draft was far from ideal and it took several interactions to achieve an acceptable thesis.

- Ideally, a student would learn from the process and show an improvement of performance in the course of the project. In such a situation, the final performance should be taken into account with greater weight.

3 The thesis and results

Below are descriptions of the thesis combined with the results that should fit the different possible marks.

mark	description of the thesis
10 Exceptional	• a) Immediately publishable in a journal in the "top 100" list of AMS's Journal Ranking or top quartile of Thomson Scientific's Journal Ranking in the appropriate area or b) Is the core research that could eventually be published in a top 20 journal (in the AMS list) • Clear, well articulated, focused, well structured, account of high level mathematics.

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Excellent
	• a) Immediately publishable in a journal indexed by MathSciNet without embarrassing the supervisor or
	  b) Is the core research that could eventually be published at a journal in the top half of Thomson Scientific's Journal Ranking or
	  c) Represents an elegant, original exposition of high level mathematics already published across several research papers available in the literature or
	  d) Represents a breakthrough invention in solving a problem that is important for a company, e.g. resulting in a product or patent
	• Clear, well articulated, focused, well structured account of high level mathematics.
	• *New* examples, computations, algorithms exemplifying the theory in study.
	• Guideline: if the situation presented itself, the supervisor would use or recommend the thesis as a reference;
	• Is accompanied by software that is readable, well-documented and reliable for the purpose, and that can be released as open-source software, without embarrassing the supervisor.

8.5 Very good	• Original exposition of high level mathematics already published across a few research papers available in the literature; • Original application of mathematics to solve a relevant problem posed by a company; • Clear, well articulated, focused, well structured account of high level mathematics. • *New* examples, computations, algorithms exemplifying the theory in study. • The text is well structured, locally as well as globally
8 Good	• Somewhat original exposition of high level mathematics already published across a few research papers; • Is accompanied by useful software, which would need some clean-up to make it fit for release. • Reasonably well written although may suffer from wordiness at places; • The text is locally well structured, and globally to a somewhat lesser extent.
7 Reasonable	• Exposition of relevant mathematics already published across a few research papers; • Reasonably well written although may suffer from typos, wordiness and subpar structure. • The text is locally well structured.
6 Sufficient	• Exposition of relevant mathematics already published across a few research papers; • Sufficiently well written although may suffer from typos, wordiness, subpar structure; • May have small mathematical mistakes; • Is accompanied by working software, which is just a prototype. • The text is locally reasonably well structured.
< 6 Insufficient	• Exposition of not necessarily difficult mathematics already published in research papers or for which a single good reference already exists; • Suffers from wordiness, lack of focus and lack of structure; • Contains many typos and/or many mathematical inaccuracies; • Contains blunt mathematical innaccuracies; • Does not related its object of study and related questions to anything else (in mathematics of elsewhere) and thus fails to motivate its existence; • Shows poor understanding of the subject studied; • Is accompanied by unreliable software; • The text is locally poorly structured.

Further thoughts.

- The difference between a 10 and a 9 is that, for original research, 9 implies a lower scientific achievement. The mark 9 can also be awarded to non-original research. For the marks from 9 to 10 we require the presentation itself to be excellent.

- The difference between a 9 and a 8.5 is that, 8.5 automatically implies no substantial new contribution to science (no original research). For an 8.5, there is already a good reference covering most of the material presented in the thesis. The presentation of the material, while very good, is not outstanding as it misses original touches or added elegance.

- The difference between an 8.5 and an 8 is that, while in both cases the student dealt with high level mathematics, the level of exposition for an 8 is only good. As for the level of mathematics, an extra guideline that can not necessarily be read off the thesis is that for an 8.5 and above the student managed to study the original problem successfully and went further than initially envisioned. For an 8, the student managed to successfully study the original problem and that was the end of it.

- The difference between an 8 and a 7 is that in the latter case the student did not deal with high level mathematics and the level of exposition for a 7 is only reasonable. A sign of the "level" of mathematics being less than 8 would be if the original project had to be shortened or simplified at parts to match the students capabilities.

- The difference between a 7 and a 6 is that, for a 6 the quality of the mathematics is lower (e.g., not deal with difficult concepts, the exposition would be very contemplatory without many new insights. A sign of the "level" of mathematics being less than 7 would be if the original project had to be shortened, simplified at several parts or even switched to something simpler to match the students capabilities

4 The thesis defence

The following should be *descriptions of the presentation* corresponding to different marks.

mark	description of the defence
10 Exceptional	• Clear, well articulated and engaging exposition; • Pitched at the correct level for the audience; • Clear, uncluttered, (mostly) typo free slides/blackboard; • Audience was very well addressed; • Well answered questions: thoughtful and complete answers; • Excellent timing in all respects.
9 Excellent	• Clear, well articulated, engaging exposition; • Pitched at the correct level for the audience; • Clear, uncluttered, (mostly) typo free slides/blackboard; • Audience was very well addressed; • A few questions could benefit from more thoughtful or complete answers; • Excellent timing in all respects.
8.5 Very good	• Clear, well articulated and engaging exposition; • Small parts of it pitched at the wrong level (too basic or too technical); • Clear, uncluttered, (mostly) typo free slides/blackboard; • Audience was well addressed; • Some questions could benefit from more thoughtful or complete answers; • Good timing overall, locally often (but not always) well adapted to the subject at hand.
8 Good	• Mostly clear and well articulated exposition; • Sometimes pitched at the wrong level for the audience; • Clear, uncluttered, (mostly) typo free slides/blackboard; • Audience was reasonably well addressed; • Some questions could do with more thoughtful or complete answers; • Some questions did not get satisfactorily answered at first and needed some prodding before an answer emerged; • Good timing overall, locally reasonably well adapted to the subject at hand.
7 Reasonable	• Ok presentation which was mostly, but not always clear and had confusing parts; • Pitched at the wrong level for the audience; • Unclear or cluttered slides/blackboard or a mismatch between the slide content and the oral presentation; • Audience was reasonably well addressed; • Several questions could do with more thoughtful or complete answers; • Some questions did not get satisfactorily answered; • Reasonable timing overall, sometimes not well adapted to the subject at hand.
6 Sufficient	• Not always clear and had confusing parts; • Pitched at the wrong level for the audience; • Unclear or cluttered slides/blackboard or a mismatch between the slide content and the oral presentation; • Audience was poorly addressed; • Several questions could benefit from more thoughtful or complete answers; • A few questions did not get fully answered; • At a number of occasions, the timing of the exposition was not well adapted to the subject at hand.

mark	description of the defence
< 6 Insufficient	• Confusing or unclear at several parts; • Pitched at the wrong level for the audience; • Unclear or cluttered slides/blackboard or a mismatch between the slide content and the oral presentation; • Wrong statements in slides/blackboard; • Audience was poorly addressed; • Several questions could benefit from more thoughtful or complete answers; • A few questions did not get fully answered; • Some questions got wrong answers; • The speaker did not seem to fully grasp the material related to the presentation; • Missed important components such as introduction, motivation, outlook; • The statement of the results was not clear; • Exposition often suffered from poor timing.