Policy and guidance on setting exam papers

September 2019

This document outlines the School's policy and guidance relating to setting exam papers. There will be a separate document on attending and marking exams.

Scope

These notes apply to exam papers for all modules that come within the remit of the Mathematical Sciences exam boards – this means all modules MTH****, as well as SEF001, SEF002, SEF014, SEF015 and SEF026. If you are teaching a module that is in some way unusual and you think special considerations may be needed, then you should consult the appropriate SEB chair during (or before) Semester A. Otherwise, you should follow the guidance and requirements below.

Using LaTeX

Exam papers (excluding computer-based exams) should be typeset using LaTeX. The college maintains a LaTeX template, but we maintain our own style file and template (which is far superior). These are updated every year by the SEB chair(s) to take account of the changing requirements of the college, and the new versions will be distributed to staff late in Semester A. You *must* use these for your exams, so that our exams have a consistent format and contain all the appropriate regulatory information.

If you have any difficulty using these, suggestions for improvements or general problems with using LaTeX, then please consult the UG SEB chair.

Rubrics

We allow three different rubrics. It is expected that at level 6 and below, you will use the "answer all" rubric; please let the UG SEB chair know if you want to deviate from this. If you have good reason to want to use something other than one of the three rubrics below, please consult the appropriate SEB chair.

"Answer all" Under this rubric 100 marks in total are available for all questions, and every question attempted counts. You invoke this rubric using `\rubricall`, which produces the following.

> You should attempt *all* questions. Marks awarded are shown next to the questions.

"Best m" In this rubric each question is worth $100/m$ marks and the candidates are allowed to answer as many as they like; all the solutions are marked, and then the best m solutions count towards the student's mark (with all solutions counting for the purpose of attaining the pass mark). m is typically four, since then $100/m$ is an integer. `\rubricbest{m}` will produce the following wording (you should write m as a word rather than a figure).

> You may attempt as many questions as you wish and all questions carry equal marks. Except for the award of a bare pass, only the best m questions answered will be counted.

"Two sections" This is a combination of the previous two rubrics: in Section A of the paper (which will typically examine the more core material) candidates should answer all questions, and in Section B they choose a specified number of questions to answer. You can split the marks between sections A and B as you wish. Using `\rubricsections{m}` produces the following.

> This paper has two sections.
> You should attempt all the questions in Section A. In Section B you may attempt as many questions as you wish. Except for the award of a bare pass, only the best m questions will be counted.

You should then begin sections A and B with `\section*{Section A}` and `\section*{Section B}`, with Section B starting on a new page.

Think very carefully before changing the rubric from previous years, and *make certain the students are aware of what the rubric will be* – you should have a clear statement on the QMplus page and an announcement in lectures by week 7 of the semester in which the module is taught.

Setting questions

Types of question

The questions should contain a mixture of material of the following kinds.

- Recall of bookwork, especially statements of definitions and theorems, but also proofs (depending to some extent on the style of the course).

- Examples where the candidates need to apply methods and theorems. Different levels of difficulty can be achieved by varying between examples the candidates have seen (in coursework or lectures) and more unusual ones. Be careful with this – weaker candidates can crumble rapidly at a hint of anything unfamiliar.

- Material that calls for more imagination – an unusual application of the results, extending a proof from the course to a new situation, etc.

If your module is heavily methods-based and you want to avoid setting an exam in which lots of the questions take the form "apply this method to this example", a variation you might try is to ask them to describe how a particular method is carried out, and/or in what circumstances a particular method can be used. But be warned that a lot of candidates who are perfectly capable of doing something are incapable of describing how to do it.

It is important to have a variety of difficulty within the questions; the marks for mathematics exams tend to be more spread out than in other subjects, which causes us difficulty when we are supposed to use the same grade boundaries (with the same meaning) as other departments. To make the marks less spread out, it is important to have a range of difficulty in the questions; in particular, there needs to be some really routine stuff to help the weaker students to pass and a small amount of tough material to curb the marks at the top end.

Follow-on questions

A popular style of question has several parts, with the later parts building on the earlier ones. For example, part (a) might ask for a definition, part (b) for a particular example illustrating that definition, part (c) for the statement of a key theorem involving the thing defined, part (d) for an application of the theorem, and so on. When setting this type of question, be careful that a candidate's inability to do an early part of the question doesn't prevent them from attempting a lot of the later parts, or you may find your weaker candidates getting very low marks.

Essay questions

It is fine to set an essay question – it can be just as good a test as more focused short questions, and many candidates welcome it – but *make absolutely sure that the candidates are expecting it, and know what is required to gain marks*. Be aware that most of our students have not written an essay since school. It is recommended that you focus on content, and award few or no marks for style and structure.

Similarity with past exam questions

It is difficult to keep writing completely original exam papers which still test the syllabus at an appropriate level, so some repetition of past questions is reasonable. It can also be a useful way to persuade students to learn particularly important concepts – if they spot that a particular item has been asked about in the exam for several years running, they will make sure they know about it.

But strive for originality as much as you can. A firm rule (which appears on the exam paper approval form that you must sign) is that it must not be possible for a candidate to pass the exam by memorising the solutions to a single past paper. Even if you comfortably satisfy this rule, provide variation wherever you can; certainly if you recycle a numerical question, you should change the numbers.

Syllabus coverage

You should aim for good coverage of the syllabus in your exam. It is very hard to quantify exactly how much of the syllabus you've covered, since different topics contain different amounts of material, and these in turn naturally generate different-sized exam questions. But you should ask at least something on at least 70% of the syllabus (according to some reasonably sensible measure). Of course, some topics will inevitably be covered in more depth than others, and students should expect variation from one year to the next. You should also be wary of the length of your exam: we have had problems in recent years with exam papers that were just too long for the time available, even though the individual questions were set at a good standard. So don't make the exam too long by trying to cover a lot of the syllabus.

Difficulty and grade proportions

With league tables in mind, we (i.e. the college and the School) are under pressure to improve our "added value", which essentially means giving more higher-class degrees relative to our students' A-level grades. In November 2015 the college set us a target of 70% first- and upper second-class degrees. As much as we would like to do this by being inspirational teachers and instilling good learning habits in our students, it also entails setting exams at a sufficient level to achieve substantial numbers of higher grades (especially in the final year), and to do this we have to adjust (or set aside) our personal views on what "pass" and "first class" mean. In the past we did a lot of scaling of exam marks to get grade proportions closer to targets, but the college has now clamped down on scaling. So we need to do more to align our standards when setting exams, and teach (and assess) the students we have, not the students we would like to have. We all know that it is absurd to claim that "pass" and "first class" should mean the same across all institutions (or even across all Russell Group institutions).

In addition, our students now have to pass more modules to get a degree than was the case previously (this is a College measure to bring us in line with the sector, which apparently is a good thing). We do not interpret this as an instruction that it should be harder to get a degree, so instead we have to make it easier to pass a module. So you need to make sure that there is a substantial amount of routine stuff (mainly from the earlier part of the course) so that plenty of students can pass. The target set by DoTP is that 90% of students should pass (after resit if necessary, and counting no-shows as fails). This means that your failure rate at the first attempt (among candidates who actually turn up) should ideally be below 15%. The average mark (especially at levels 5 and 6) should ideally be in the low 60s.

Useful information for the candidates

It is important to give the candidates as much guidance as you can about what they are required to do; they are being assessed on their mathematical ability and their understanding of the module, not on their ability to work out what you want them to do. The fewer queries you have to answer during the exam, the better.

You can give the candidates general instructions for the whole paper, which you can set out before the first question. The style file provides the command \instructions{} which will typeset the instructions in a nice box. For example, you might tell them that they can use a particular theorem whenever they want, or that they must always show their working, or you might set out some notation that you use repeatedly.

For individual questions or parts of questions, you should give guidance on whether you are allowing them to quote certain results. For example, you might say "You may use Pythagoras's Theorem, provided you state it clearly", or alternatively "If you use Pythagoras's Theorem, you should prove it". When asking the candidates a particular question, indicate how much justification is required. So instead of asking "What is the value of $e^{i\pi}$?", you might use one of the following alternatives.

1. Write down the value of $e^{i\pi}$.

2. What is the value of $e^{i\pi}$? Briefly justify your answer.

3. Give, with proof, the value of $e^{i\pi}$.

You must also tell the candidates how many marks are available for each question or part-question (although this information need not be quite as fine-grained as your full mark scheme). This will help the candidates to know how much is required of them. The style file provides a command \marks{} which will typeset the number of marks neatly in the margin.

Solutions and mark scheme

You are required to provide *full* solutions when you submit the paper. (In particular, this means that it is not enough to say for part of a question "Bookwork – see the lecture notes.") One reason for giving full solutions is that it shows how long a full solution to a question is; this might help you to realise that although you've set a question at a suitable difficulty level, the solution is too long to be reasonably expected in the time available. Another reason for writing full solutions is that the people assessing your paper (the checker, the external etc) typically won't read your lecture notes, and may not know (for example) which definition of a particular concept you've given in lectures; often this can have a significant impact on the difficulty of later parts of the question.

You must also indicate whether each part-question is bookwork, similar to examples seen in lectures/coursework, or unseen – again, this has a big impact on how difficult the question is, and helps assessors to judge whether your paper is overall at the right level of difficulty.

It is often suggested that you write out solutions by hand, in order to test how long it takes you to write them – you should be able to write out full solutions in much less time than is available to the candidates, since you don't need thinking time. This is up to you – if you're confident that your paper is of a suitable length, then you might feel that typed solutions are easier for the assessors to read; typing the solutions also gives you the option of copying and pasting bookwork parts from your typed lecture notes.

You should include with your solutions a fairly precise mark scheme – as a rule you should not allocate more than five marks to a question or part-question without sub-dividing them and saying how many marks are awarded for different aspects. You can modify the mark scheme later, for example if you discover that a lot of candidates have taken an unusual approach which doesn't fit the scheme very well, but you should have quite a detailed scheme to begin with.

Calculators

You should decide whether you're going to allow candidates to use calculators far enough in advance that you can given them plenty of warning. *You must have a clear statement on the QMplus page by week 7 of the semester in which the module is taught.* Beware of the capabilities of modern calculators (for example, with actuarial functions). Also note that there is now an approved list of calculators produced by the College, and invigilators will check that candidates' calculators are on the list. You need to add a statement at the beginning of the paper about calculator use. The style file provides commands to produce appropriate wording for the use of calculators: the command \nocalc should be used when calculators are not allowed, while if calculators are allowed then use \yescalc, followed by \statcalc if appropriate.

Resit and first-sit candidates

There may well be candidates who took the module in a previous year, because (through excused absences) they haven't yet exhausted all their attempts. You will be informed by the SEB chair whether you have such candidates, and in which year(s) they took the module. You *must* produce an exam paper which is appropriate for these students, either by making sure that your main paper is suitable, or by producing a separate paper (which might differ only slightly from the main paper). If you were not the lecturer when these students took the module, then check with whoever was the lecturer that the paper is suitable – there may be a syllabus change you're not aware of, or the notation you use may be alien to these students.

If you do produce a different paper for the resit/first-sit candidates, make sure you use the command \resittrue in your LaTeX file, as this will put the words "resit paper" in the necessary places. If your paper is for the resit candidates from a particular year (with those from another year taking the main paper), then this should be made clear on the front of the paper also (consult the SEB chair if you are unsure about typesetting this). *Never* use "first-sit" on the front of an exam paper (even if the candidates from a previous year are all first-sit rather than resit candidates).

Submission and scrutiny

You will be required to submit your exam paper to the maths office in approximately week 4 of the semester in which the module is taught; if you did not also teach the module last year, then the

deadline will be slightly more relaxed. Exact deadlines will be announced by the SEB chair at the start of the semester. Note that these deadlines are for submission *after* the exam has been checked by the checker; you should liaise with your checker to ensure that you give them enough time to do their job. At the point you submit your paper, you should have done your best to make sure it is free from errors; do not assume that other people will do this job for you.

You should submit

- the paper,

- last year's paper (unless the module is new, in which case you should provide a sample paper),

- the solutions,

- the syllabus,

- the appropriate blue exam paper submission form(s) (signed by you and the checker), and

- the mid-term test paper, if there is a test for the module.

The paper will then go to the Scrutiny Sub-Committee. This is a group of a few of your colleagues in SMS, headed by the SEB chair. As well as checking for errors, they will consider the difficulty and length of the paper, and may make suggestions for alterations. If the SSC has any changes to suggest beyond basic typos and formatting, they will ask you to make these changes before the paper goes to the external; you should give the office staff a revised version of the paper, and solutions if these have changed too. Then the paper will be sent to the external examiner, who may also have some suggested changes.

You as lecturer are best placed to judge whether the exam paper is suitable, since you have been in all the lectures and set the coursework. Please take a sensible approach to the advice given by the checker, the Scrutiny Sub-Committee and the external examiner. In case of a dispute, the Scrutiny Sub-Committee may insist on changes, and the Head of School and Director of Taught Programmes will step in if necessary. But I hope that we're all too sensible for this to be necessary.

After the external examiner has looked at your paper, his or her comments will be given to you together with a green form on which you need to write a response (either a confirmation that you have made the changes suggested, or an explanation of why not). The final version of the paper should be submitted to the office in week 9, and the completed green form should be given to the SEB chair.

Most examined modules have more than one code according to the cohort of students taking the module, and typically the exams for the different codes will be identical apart from the module code. If this is the case, you should produce a single exam paper containing all the codes. To do this, you use the command \coursecode for each code; for example you can use

\coursecode{MTH6120}
\coursecode{MTH6120P}

in your LaTeX file. If you're unsure which module codes apply to your module, consult the appropriate SEB chair.

Keeping students informed

It is very important to keep students informed about the exam. In particular, you must tell them exactly what the rubric will be, and they should have a good idea of the "style" of the exam – heavy/light on bookwork, long/short questions etc. If you are teaching the module for the first time, then carefully consider how much your exam-setting style differs from that of the previous lecturer, and contemplate producing a sample exam paper (or least some sample questions). If in doubt, consult the relevant SEB chair. If you are teaching a new module or you are changing the rubric from last year, you *must* provide a sample exam paper. There is no need to produce solutions to the sample paper, but you should outline solutions to any students who ask you.

You must give the students information about the exam both in lectures and on the QMplus page, and in the revision lecture if you give one.

What the checker should do

As checker, you provide the first safety net for the paper. You should check carefully that it is free from errors. This means not just typographical errors, but mathematical ones – for example, are all the necessary hypotheses given when the candidates are asked to prove something? For a numerical question, check through the calculation in detail.

You should also check that it's not possible for a candidate to give an unexpected but correct answer to a question which then makes subsequent parts much easier. For example, consider the following question.

1. Suppose V is a finite-dimensional vector space.

    (a) Define what is meant by a *basis* of V.
    (b) Prove that if $\dim V = n$, then any basis of V contains exactly n elements.

For part (a) a candidate could give the (perverse but legitimate) answer "A linearly independent subset of V containing exactly $\dim V$ elements", rendering part (b) trivial.

Check also that the paper is of the right standard. You know what the teaching is like here better than the external does, so you can give a good view on how well the paper fits QMUL standards (while the external gives a view on national standards). The lecturer should provide you with the previous year's paper, the syllabus and the test paper (if applicable), and you should consider the exam paper in conjunction with these. Also check that the paper covers the syllabus to a suitable extent.

Don't be afraid to consult the SEB chair if you are unsure whether the paper is suitable.

Summary of requirements

Here is a checklist of what is required for your exam.

- Decide what the rubric will be, and announce it to students (via QMplus and in lectures) by week 7.

- Decide whether calculators will be allowed, and announce this to students (via QMplus and in lectures) by week 7.

- If a sample paper if required (which it certainly will be if the rubric has changed or the module is new), then produce one and make it available on QMplus.

- Consult your checker about when they need to receive your exam paper in order to do a proper job.

- Write your exam paper in good time (using the LaTeX files provided) to give to the checker, and give it to them with appropriate supporting materials.

- Make any appropriate changes following checking and submit your paper to the office (with all the required supporting material) by the deadline set out by the SEB chairs.

- Make changes as appropriate after the Scrutiny Sub-Committee has looked at the paper.

- After the external has seen the paper, make the necessary changes, complete the documentation and submit the final version to the office by the deadline set by the SEB chairs.