

Teaching Committee report to the Faculty Board

Examinations for Parts IA, IB and II of the Tripos, 2013

1 Introduction

The Committee met three times, for two hours each time, to consider the examinations. We looked at:

- the examiners' reports;
- the external examiners' reports;
- the examiners' comments on their questions;
- the examination statistics (take-up rates, etc) this year and last;
- the examination papers;
- the analysis of the paper lecture questionnaires;
- the responses to the on-line questionnaires;
- the report from the CATAM assessors (Parts IB and II);
- the regression analysis of Part II question marks;
- the Schedules booklet;
- letters sent each year by the Chair of the Faculty Board to the examiners (individually);
- the 'Interpretation of Marks' letter sent by the Chair of the Faculty Board to Directors of Studies;
- the letter sent to examiners shortly before the examinations explaining the arrangements for the examination ('Examiners' Memorandum');
- the mark checkers' instructions document;
- the timetables for the examiners' meetings for the three Parts of the Tripos;
- the guides produced by the Undergraduate Office (née Faculty Office) for the chairs of examiners;
- and the instructions given to the invigilators by the Board of Examinations.

In our report, we have made recommendations where we believe that action by the Faculty Board would be appropriate. We have not generally highlighted points of a purely administrative nature: that is for the chairs of this year's examiners to pick up from the previous year's examiners' reports.

2 External Examiners' reports

We note with pleasure that the external examiners, without exception, commented favourably both on the examination process and also on the performance of the candidates. The six external examiners' reports include comments such as:

I am pleased to find in place a rigorous and efficient procedure for setting, checking and reviewing examination papers. Marking of examination scripts was conducted fairly, with great attention and care.

To the best of my knowledge, Cambridge appears to be the last university in the country where examination of first year mathematics has not succumbed to pressure to slice questions into sub-questions and guide the candidate through pre-set steps and substeps. In this sad environment, Cambridge continues its noble mission of maintaining the Mathematical Tripos as a benchmark of genuine mathematics. (Part IA)

The exams were generally of an appropriate standard, allowing a wide range of marks to be obtained distinguishing the excellent candidates at the top and the weak candidates at the bottom. (Part IB)

As in 2012 the whole process seemed to run extremely smoothly. Overall the exam papers were produced to a very high standard, with a range of interesting questions of differing levels of difficulty. I thoroughly enjoyed tackling the draft questions myself. (Part IB)

The questions and model solutions were carefully prepared and the number of typos and errors [was] much smaller than last year. I continue to be impressed by the breadth of topics covered in the exam questions and by the examination performance of the students in general. (Part II)

The processes generally work smoothly and produce results which everyone can be proud of. Overall the standards of the examination appear to be entirely appropriate for the group of students who take it, and compare favourably with other institutions I have knowledge of. (Part II)

On the evidence of this year's examination, intellectual standards in the Mathematical Tripos remain very high. They are certainly comparable with or above those at other leading UK institutions of which I have direct knowledge. The best candidates demonstrate great ability over a wide range of subjects. Even at the lower levels of classification, I believe there is strong evidence of mathematical maturity and skill. I remain of the view that the structure of the examination which involves shorter and more straightforward questions ensures, serves as an effective discriminant across the ability range of the candidates. The course provides a coherent presentation of advanced mathematics at a level and depth that is exceptional. (Part II)

Other matters raised by the external examiners are dealt with in the following sections, in conjunction with matters raised in the examiners' reports.

3 General Matters

3.1 Errors

This year the following errors were reported, which affected 9 out of a total of about 280 questions: one error in Part IA (as last year); two errors in Part IB (three last year); and six errors in Part II (as last year).

Any error is unfortunate, but in the last two years there have been significantly fewer errors than in many recent years. Furthermore, the errors appear to have been mostly of a relatively minor nature.

3.2 Differences in difficulty between questions

As last year, there were significant disparities in the levels of difficulty of questions and courses, both as perceived by candidates (on-line questionnaire) and as measured by the examination statistics (take-up rates, average scores and percentage of alphas), in all parts of the Tripos this year. Both the Part IB

external examiners expressed concern about this, though one remarked that such differences would only be problematic if there was a long-term trend. In Part IA and Part IB, the pure examination questions (and, in Part IB, the applicable questions as well) were found harder than the applied questions. This is as it was last year, but not the year before that.

Last year, to help address this problem, the Faculty Board issued guidance to the examiners on the level of difficulty of questions, recommending targets of (0.40 – 0.45) alpha rate on long questions and (0.55 – 0.60) beta rate on short questions. This guidance was received by the examiners rather late (January) in the setting process. Some examiners were unaware of the guidelines even at the time the examiners' reports were written. We believe that it will take a little while for this new idea to bed down, and we will monitor the situation again carefully in the coming year.

Meanwhile, we **recommend** that these targets be included in the guidelines sent by the Undergraduate Office to the chairs of examiners (as well as in the letter sent to all examiners by the Chair of the Faculty Board). In addition, we **recommend** that these targets be sent to all Part II lecturers.

3.3 Invigilation

There were no significant problems with invigilation. However, the Part IA Examiners reported that some invigilators were not aware that examiners would be present in the building throughout the three hours of the examination. Given that this is not the only aspect of the Mathematical Tripos examinations which differs from other examinations, we **recommend** (as we recommended last year, for similar reasons) that the Faculty Board ask the Board of Examinations whether it would be possible to ask the invigilators to read out a maths-specific script at the beginning of the examination. The script actually read by invigilators and a proposal for a maths-specific script is attached.

3.4 Feedback on comments by external examiners

This year a new form was introduced so that examiners can explain to the external examiners how the questions have been modified as a result of their comments.

The Undergraduate Office reported that forms were completed by all of the Part IA examiners, five out of eight of the IB examiners and nine out of eleven of the Part II examiners. The absence of a response was remarked upon by one of the Part IB external examiners.

Various reminders from the Undergraduate Office failed to produce a complete set of responses, but we hope this will improve as the new arrangement becomes a more familiar part of the process.

3.5 CATAM plagiarism

A number of external examiners are very critical, justly so in our view, of the way that plagiarism in CATAM is dealt with. This criticism is not directed at the CATAM Committee, but at the constraints placed on the examiners by University policy. This has been a long-running issue that has come to the notice of the Teaching Committee often in the past.

Professor Wilson (Part II External Examiner) in particular notes that low-level plagiarism is a no-risk strategy: the worst that happens is that the candidate is caught, convicted and loses only the few marks obtained plagiaristically. The only element of risk is that the case might be deemed sufficiently watertight and serious to be referred to the University Advocate. This is hardly consistent with the threatened draconian penalties and, according to Professor Schroers (Part II External Examiner) is lenient compared with the practice at other departments in the UK.

Professor Schroers recommends heavier penalties such as the loss of all CATAM project marks for any case of plagiarism. Professor Wilson suggests a 'sensible system of graduated penalties, which can be imposed locally'. Professor Young (Part II External Examiner) believes that CPAC, rather than any higher University authority, is the appropriate body to decide levels of sanction against 'poor scholarship'. We strongly **recommend** that the Faculty Board discusses the matter with the relevant University authorities and, given the strength of the criticism expressed by the external examiners, that this be done at the earliest opportunity.

Two of the external examiners suggested that CATAM submissions should be made electronically in order to make plagiarism easier to detect. We noted that this might also act as a deterrent, by increasing the perceived risk of being caught (though it would not address the size of the penalty for being caught). We saw, in addition, academic benefits in requiring electronic submissions (at least for the text). We therefore **recommend** that the Faculty Board considers making this change.

3.6 Time allowed for meetings

The Part IB examiners discussed the time allowed for the meetings in which the questions were discussed. At these meetings, examiners have their first opportunity to discuss questions from subject areas. The importance of examiners taking joint responsibility for all the questions (thereby reducing the number of errors and helping to ensure comparability in standards) has often arisen in our reports. We therefore believe that it is essential to allow enough time for these meetings and **recommend** that it is suggested, perhaps in the Examiners' timetable (for all parts of the Tripos) and certainly in the guidelines sent by the Undergraduate Office to chairs of examiners, that enough time is allowed to scrutinise each question carefully: (say) up to four hours for at least one of the meetings.

3.7 Faculty Secretary and Computer Officer

All the examiners' reports praised the excellent support given by the staff of the Undergraduate Office, and in particular by Amy Dittrich. We **recommend** that the Chair of the Faculty Board expresses the appreciation of the Board for their work.

The examiners in all parts of the Tripos found the expertise of John Sutton invaluable. There was much praise for the new on-line mark entry system. We **recommend** that the Chair of the Faculty Board expresses the appreciation of the Board for Mr Sutton's work.

4 Part IA

4.1 Physics marks

The examiners reported that there was some difficulty in acquiring the marks for the physics paper, and protracted requests were required. We **recommend** that a standard letter be produced that can be sent to the senior examiner in physics explaining what is required (i.e. raw, unscaled marks at the earliest opportunity) and that the guidance for the Chair of Part IA examiners (Mathematical Tripos) be updated appropriately.

4.2 Rubric violations

The examiners noted that the number of excess questions is typically around 140. They remark that it might be of interest to survey the corresponding students to ascertain whether they understood the rubric. We were not persuaded that this would be worthwhile: the rubric is clearly explained in the e-mail sent to the students before the start of the examinations and we (including our two student members) have never heard of a candidate who misunderstood (or even forgot) the rubric.

4.3 Order of papers

The papers for many years have been taken in the order 1243, for historical reasons relating to the extinct Mathematics with Computer Science option. We **recommend** (as in previous years) that the papers are taken, if possible, in the natural order in future. We note that the Faculty Board agreed to pursue to possibility of changing the usual days upon which the papers are taken (to spread them out) and that this might necessitate a different unnatural ordering (1324) to accommodate the candidates taking the mathematics option of the Computer Science Tripos.

4.4 Overall standard of questions

The Faculty Board target alpha rate, agreed last year, is 0.45 – 0.50. The average this year for all Part IA courses was 0.60, significantly higher than the target range; and the alpha rate for Vector Calculus was 0.76 which is 50% higher than the top of the target range. However, the beta rate was 0.59 which is within the Faculty target range of 0.55 — 0.60.

We **recommend** that this year’s examiners study last year’s questions with a view to aligning the alpha rate for 2014 with the Faculty target range.

5 Part IB

5.1 Soundness of process

Dr Willerton (External Examiner) was concerned about the number of errors in the transcriptions of marks, having found two himself in 20 scripts. We reviewed the process carefully and investigated, as far as we could, the two errors Dr Willerton refers to.

Such errors only occur if the mark is entered incorrectly by the examiner, and if the checker, who compares lists of marks with marks on scripts, fails to notice. It is unlikely, in our opinion, that an error involving a numerically incorrect mark would survive this check; but a correct mark attributed to the wrong question might go unnoticed. However, this should be revealed when the Chair of Examiners checks the computer-generated list of discrepancies between the master cover sheet and the lists of marks, provided he or she resolves discrepancies by referring to the scripts.

There is a final safeguard. Each candidate is provided with a detailed breakdown and can query the mark of any question if he or she thinks that something is amiss (and the errors corrected by Dr Willerton might otherwise have been found by the candidates in this way).

We do not believe that, within reason, anything can be done to improve the process. We think that the two transcription errors unearthed by Dr Willerton appeared as discrepancies between the master cover sheet data and the mark list, which were incorrectly resolved. We **recommend** that Chairs of Examiners are advised (in the guidelines provided by the Undergraduate Office) always to refer to the scripts when attempting to resolve such discrepancies (even though the resolution may appear obvious).

5.2 Comments of lecturers

Dr Willerton (External Examiner) recommends that external examiners are sent the comments of the lecturers on the draft questions. However, by the time the questions reach the stage of being sent to the external examiners for the first time, the lectures have agreed that the questions are suitable, by ticking boxes on a form, all the negotiations having been completed (normally orally). There is surely no point in sending these completed forms to the external examiners.

5.3 High alpha rate

Dr Hammerton (External Examiner) alludes to applied questions for which there was a high alpha rate. He suggests that examiners identify 5 or 6 marks on each long question that distinguish an alpha answer from a beta answer. This is good advice but we believe that it is typically what examiners do when constructing their mark schemes. The questions he refers to were simply misjudged and turned out to be too easy. (Professor Young (External Examiner, Part II) notes that ‘it is evident that great care and thought are applied, in particular at the alpha/beta borderline’.)

5.4 Disparity between pure and applied questions

Both External Examiners point out that, again, there was a significant disparity in both take-up rate and alpha rate between pure, applicable and applied questions. This matter is discussed above. Here, we note that the alpha rate for pure questions (0.37) is the same as it was in the previous year (and lower than the

target range) while the alpha rate for the applied questions decreased to 0.59 (still higher than the target range) from 0.69 in the previous year, so there was in fact some reduction in the disparity.

6 Part II

6.1 Late questions

Following a recommendation from the Teaching Committee last year, the Faculty Office (now the Undergraduate Office) implemented a system of reminders (similar to that used in Part III) to encourage Part II lecturers to provide draft questions in time. The examiners reported that the system worked well, and should be retained.

6.2 Alpha weighting

Professor Wilson (External Examiner) raised the matter of the effect on the merit mark of a change of a single raw mark (from 14 to 15). The Faculty Board has discussed this very many times in the last 10 years and we do not recommend re-opening the issue again yet. We note, though, that last time it was discussed in depth various different models were suggested and tested on existing class-lists and the effect on the ordering of candidates was minimal.

It should be borne in mind that the candidates and the examiners are now accustomed to and understand the existing system of quality marks.

6.3 Range of skills

Professor Schroers (External Examiner) refers to the comments he made last year about the narrow range of skills tested by the Tripos: basically, he thinks, just the ability to do examination questions. We responded last year by explaining that these matters are currently under discussion by a Faculty Working Group; this is still currently the situation — perhaps unsurprisingly, since any change would be a very significant shift from the current situation and needs a great deal of deliberation. We note, as last year, that other skills are provided by the supervision system even though they are not tested explicitly in the examinations, and of course by CATAM.

6.4 Efficacy of C-courses

Professor Young (External Examiner) commented that some C-courses do not appear to be meeting fully their objectives and urges that they be reviewed.

As last year, we were discouraged by the low take-up rates of some of the C-courses, as shown in the following table of take-up rates¹ for ‘short’ questions.

¹The course take-up rates are determined as follows. A 10% take-up rate on a given question means that the question was attempted by 10% of the candidates; the course take-up rates given in the table are the question take-up rates averaged over the questions for the course.

Course	2013	2012	2011
Coding and Cryptography	14.3	17.9	24.1
Geometry and Groups	2.7	3.0	6.8
Number Theory	30.5	45.0	48.4
Topics in Analysis	15.4	5.7	7.7
Statistical Modelling	9.4	4.8	6.8
Classical Dynamics	14.4	12.4	15.1
Cosmology	3.0	6.4	5.2
Dynamical Systems	9.5	8.1	8.6
Further Complex Methods	13.4	12.8	15.8
Mathematical Biology	9.2	6.0	8.1

Of course, we cannot expect that all 10 C-courses will have the same take-up rate as Number Theory has now has; nevertheless, it cannot be right that so many of these courses, which are intended for the less strong students, have such low take-up rates.

Last year we gleaned from the student questionnaires some reasons for these low take-up rates, and our conclusions remain the same this year. For Cosmology and Dynamical Systems there was just too much material in the schedule, and a new schedule for Cosmology has been implemented this year. For Geometry and Groups and Topics in Analysis it is hard to escape the conclusion that it is the courses themselves that are unsatisfactory, and these courses are (still) under review by a working party.

We also noted the exceptionally low take-up rates for Partial Differential Equations (4.4% in 2013, 1.8% in 2012; 0.6% in 2011). It seemed to us that a review is overdue. We suggested last year that Dynamical Systems could be designated a D-course (with no change of schedule) and Partial Differential Equations be replaced, as a C-course, by something akin to the old and successful Partial Differential and Integral Equations course, while the current Partial Differential Equations course is found a berth in Part III. A small subcommittee of the Curriculum Committee is currently considering a possible schedule for the new C-course.

We **recommend** that the Faculty Board ensures that steps are taken to improve the situation for next year.

6.5 Relative difficulty of questions

We inspected the bar-charts that show the relative difficulty of questions on the different courses taking into account the ability of the candidates attempting the questions. These charts are sent to the lecturers as well as the examiners each year. It seemed to us that it would be useful for the lecturers and examiners to have the analysis not just from the previous year but from the year before that as well and we **recommend** that this be done. We also **recommend** that the analysis be accompanied by an explanation of what exactly the bars on the charts represent.

6.6 Timing of the final meeting

Professor Wilson (External Examiner) objected to having to spend the Sunday in Cambridge in order to prepare for the final meeting on the Monday. He suggests holding the final meeting a day later, which would still allow plenty of time before the results are circulated on the Wednesday afternoon. Professor Young (External Examiner) points out that the marking time is very compressed and would benefit from the extra time if the final meeting were later. We noted that having the Part II and Part III final meetings on the same day may be awkward, but **recommend** that the Chair of Examiners reconsiders the timing of the final meeting.

6.7 Relation between marks and quality marks

Professor Wilson (External Examiner) suggests a ‘more nuanced picture at the borderlines than the simple merit mark’. We discussed this idea (this year, as well as last year), but concluded that it would add additional variables (and more subjectivity) to the process with little benefit; in most situations, a well considered mark scheme, constructed with the alpha and beta points in mind, should suffice.

We wondered whether the external examiners see the Teaching Committee report; we hope that he does not believe that his suggestions were not adequately considered. We **recommend** that our report (as well as the Faculty Board’s response to the General Board) be sent to External Examiners (or that they be provided with the URL of the Teaching Committee website when the report is uploaded).

6.8 External Examiners’ expenses

We hope that Professor Wilson’s complaint regarding the expenses of External Examiners, repeated from last year, will be considered by the appropriate body. (Surely accommodation can be arranged and pre-paid by our administration?)

7 Summary of recommendations

- 3.2 that alpha rate targets be included in the guidelines sent by the Undergraduate Office to the chairs of examiners (as well as in the letter sent to all examiners by the Chair of the Faculty Board)
- 3.2 that alpha rate targets be sent to all Part II lecturers
- 3.3 that the Faculty Board ask the Board of Examinations whether it would be possible to ask the invigilators to read out a maths-specific script at the beginning of the examination
- 3.5 that, in view of the strong criticism of the External Examiners, the Faculty Board discusses with the relevant University authorities at the earliest opportunity the possibility of implementing more severe penalties for plagiarism
- 3.5 that the Faculty Board consider requiring electronic submissions for CATAM
- 3.6 that it is suggested, perhaps in the Examiners’ timetable and certainly in the guidelines sent by the Undergraduate Office to chairs of examiners that enough time is allowed in the examiners’ meetings to scrutinise each question carefully
- 3.7 that the Chair of the Faculty Board expresses the appreciation of the Board to the Undergraduate Office and to Mr Sutton for their work
- 4.1 that a standard letter be produced that can be sent to the senior examiner in physics explaining what is required (i.e. raw, unscaled marks at the earliest opportunity) and that the guidance for the Chair of Part IA examiners (Mathematical Tripos) be updated appropriately
- 4.3 that the Part IA examination papers are taken, if possible, in the natural order in future
- 4.4 that this year’s Part IA examiners study last year’s questions with a view to aligning the alpha rate for 2014 with the Faculty target range
- 5.1 that Chairs of Examiners are advised (in the guidelines provided by the Undergraduate Office) always to refer to the scripts when attempting to resolve discrepancies between the master cover sheets and the marks lists
- 6.4 that the Faculty Board takes steps to improve the situation regarding the unsuitability of some C courses in time for next year
- 6.5 that two years’ of statistical analysis be sent to the lecturers and examiners in Part II, and that the analysis be accompanied by an explanation of what exactly the bars on the charts represent
- 6.6 that the Chair of Part II Examiners reconsiders the timing of the final meeting

6.7 that our report (as well as the Faculty Board's response to the General Board) be sent to External Examiners

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