

Teaching Committee report to the Faculty Board

Examinations for Parts IA, IB and II of the Tripos, 2011

1 Introduction

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

- the Examiners' report;
- the External Examiners' reports;
- the Examiners' comments on their questions;
- the examination statistics;
- 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.

We also looked at letters sent each year by the Chair of the Faculty Board to Chairs of the Examiners, and the 'Interpretation of Marks' letter sent by the Chair of the Faculty Board to Directors of Studies.

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:

Generally, the quality of the candidates' scripts is very high. The very best candidates wrote exemplary papers and seven obtained a full set of alphas. The level of questions is appropriately challenging and Cambridge maintains its very high standard. (Part IA)

My conclusion about the exams process is that it is rigorous, and has been conducted with great care by a thorough and committed group of examiners. The great majority of candidates showed considerable achievement, and those at the top end showed impressive ability. I am satisfied with the outcome. (Part IB)

The examination was of a suitable standard for Part IB. On the whole, I am satisfied that the class boundaries are correct. (Part IB)

The Part II course covers a wide range of topics to a high level. The programme provides a broad range of skills appropriate to the further study in and the application of mathematics. The standard of the examination questions is challenging, but fair. The structure of the examination continues to be a strength of the examination system at Cambridge, enabling both those who excel in a particular area and those who have a good grounding in in a wider range of topics to do well. (Part II)

The standards in general are high, and at the top end some candidates give sensational performances. Even at the bottom end of the range candidates are able to demonstrate some achievement, with all scripts showing some evidence of quality learning, even if the quantity is minimal. Thus the standards of the examination appear to be entirely appropriate for the group of students who take it. (Part II)

Standards in the Mathematical Tripos are high, 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, but even lower on the class list there is strong evidence of mathematical maturity and skill. The structure of the examination ensures that it serves as a useful discriminant for weaker candidates too. (Part II)

There follows a summary of the points raised in the Examiners' reports which the Committee believe need the attention of the Faculty Board. 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. We are pleased that the annual meeting of the Directors of Studies has again requested a copy of this report in time to be able to contribute to the Faculty Board discussion.

2 General Matters

2.1 Errors

This year the following errors were reported, out of a total of about 280 questions: one error in Part IA; one error in Part IB; and twelve errors in Part II, to which should be added a Classical Dynamics question that was definitely off-syllabus (the examiner was surprised by the low uptake and noted how few could write down the Hamilton–Jacobi equations, which were in fact not examinable). The Part II and Part IA Examiners' report contains information about the nature of the errors and when they were corrected. We found this helpful and continue to **recommend** this practice.

The persistently large numbers of errors in Part II is very disappointing. It has an obvious adverse effect on individual students in the examination (which cannot be satisfactorily mitigated with any certainty despite the examiners' best efforts and intentions) and creates damaging doubts in the minds of students in future years.

Clearly, Part II is a very different examination from Part IA (and even from Part IB) where probably most of the questions can be well understood by most of the examiners. In Parts IA and IB, it appears that the examiners, having thought up and honed the questions, generally take very seriously their responsibilities for the questions individually and collectively. In Part II, the questions are proposed by the lecturers and each examiner probably has no more than a passing familiarity with all but half a dozen or so of the 35 courses.

An inspection of the listed errors reveals no pattern: the questions on eight courses and set by seven examiners contained errors. Some errors were rather slight. One was only discovered after the examination, the 22 candidates who attempted the question (20 of whom obtained alphas) obviously thought it too slight to be worth mentioning. Some were definitely easily avoidable (for example, the missing factor in a Cosmology question could easily be spotted by anyone because the relevant equation was dimensionally incorrect). Nearly all the errors occurred in complicated formulae, often in lengthy questions (one question was $1\frac{1}{4}$ pages long!).

In material of this length (about 160 questions and about 100 pages) and complexity, errors are bound to arise, and it is difficult to see a way to improve the situation. However, two effects may be significant: some examiners may mistakenly assign some responsibility to the lecturers (and therefore perhaps do not check as thoroughly as they should); the very specialised nature of the material and the sheer number of questions may discourage some examiners from checking their colleagues' questions. The committee **recommends** that the letter from the Chair of the Faculty Board to examiners mentions these two points explicitly with regard to the Part II examinations, and re-emphasises the responsibility of the examiners collectively for questions.

2.2 Allowance towards an Ordinary Degree

Next year, for the first time, examiners will no longer be able to award candidates an allowance towards an Ordinary Degree.¹ The Faculty Board will recall its previous decision (Minute 53/2011) to maintain the current standard of the third class, so that all candidates performing at the level below that of a third class should be failed. We **recommend** that next year's (2012) examiners be apprised or reminded of this decision.

2.3 Classification criteria at the third/fail border

The Teaching Committee has discussed classification criteria and merit marks almost every year for the last 15 years. We think that the subject has been aired thoroughly and, as a result, fair, transparent and quantitative primary classification criteria have emerged and been agreed by Faculty Board. These primary criteria, which describe the relative weight that should be given to marks, alphas and betas at the borders between classes, came into force in 2008/9 and are given by

First / upper second	$30\alpha + 5\beta + m$
Upper second / lower second	$15\alpha + 5\beta + m$
Lower second / third	$15\alpha + 5\beta + m$
Third/ ordinary or fail	$2\alpha + \beta$ together with m

This year there was again general approval for this scheme amongst the External Examiners. In particular, several of them commented positively on the fact that these primary criteria are made explicit to the candidates (via the Schedules), and that they were closely adhered to by the examiners.

The Part IA Examiners noted that the Faculty does not currently give guidance on the relative importance attached to $2\alpha + \beta$ and m at the 3rd/Ordinary borderline. The Teaching Committee noted that the verbal criteria state that *Candidates placed in the third class will have demonstrated some knowledge but little understanding of the examinable material. They will have made reasonable attempts at a small number of questions, but will have lacked the skills to complete many of them.* We thought that the primary criterion ($2\alpha + \beta$ together with m) provides a steer towards the interpretation of the verbal criteria, without being too prescriptive, while the accompanying statement *At the third/fail borderline, individual considerations are always paramount* makes it clear that the examiners are to use their academic judgment in taking into account other considerations. We therefore recommend taking no action at present, and see if examiners next year have difficulty applying the criteria.

2.4 Use of the merit mark to order candidates

For the convenience of examiners, the list of candidates in the final examiners' meeting is ordered by a merit mark defined as $30\alpha + 5\beta + m - 120$ for $\alpha > 8$ and $15\alpha + 5\beta + m$ for $\alpha \leq 8$. Provided the kink at 8α falls within the 2.1s, the merit mark serves as very good proxy for the classification criteria (with candidates near the 1st/2.1 boundary ordered by the upper formula, and those near the lower boundaries by the lower formula; candidates near the 3rd/Fail boundary are considered individually.)

Examiners reported that there was difficulty in classifying candidates at the 2.1/2.2 border, especially in Part IB where, perhaps because of slightly easier than usual examinations, some candidates had 9 or more alphas and were initially ranked by the wrong part of the merit formula for this boundary.

Professor Mansfield (Part IA External) also noted that, though the classification criteria are prescribed in the Schedules and in the Chair of the Faculty Board's letter to examiners, the information provided on borderline performances to Directors of Studies in the 'Interpretation of Marks' (partially quoted in later sections of the Schedules) is expressed in terms of the merit mark. This has the potential to cause confusion among students and examiners.

The Teaching Committee considered a range of options,² but did not see an easy way of bringing the merit-mark order exactly into line with the classification criteria (other than redefining the criteria to

¹Ordinary Degrees will continue to be awarded, but only by recommendation of the Applications Committee, for example to a candidate who has obtained the Honours standard in Parts IA and IB but failed Part II.

²For example, we considered but do not recommend either using several ordered lists or moving the 8α breakpoint.

be the merit mark, which we do **not** recommend.³⁾ We recommend a number of measures to make the existing procedures clearer.

For the first time this year, the few candidates in the merit-mark ordered list whose merit mark did not coincide with the relevant primary criterion were flagged and annotated with that criterion. We **recommend**:

1. The same method should be used next year, but that clearer explanation of the flags and their use is given on the print-out.
2. The Schedules and the Chair of the Faculty Board's letter to examiners should include a statement that the merit mark is only a proxy for the primary classification criteria, and that the former is not used for classification purposes.
3. The performance of the borderline candidates should be described in terms of the primary classification criteria only (for example, $30\alpha + 5\beta + m$ at the 1/2.1 borderline).
4. The merit mark should continue to be used to generate the percentage mark for transcripts and to order the candidates in lists sent to directors of studies and tutorial offices.
5. The formula for the merit mark and the algorithm for the conversion to transcript percentage should appear in the preliminary section of the Schedules booklet, with an explanation of the use of both. The method of translating marks from the Physics paper for those taking the Mathematics with Physics option in Part IA should also be explained in the Schedules booklet.

2.5 Design and structure of the examination and course

We **commend** to the Faculty Board the closing comment of Professor Wilson (External, Part II), quoted here in full: *The 'synoptic' rather than 'modular' assessment is a great (and possibly unique) feature of the Cambridge system. It allows every student to study a quantity of material that is appropriate to them, and permits the award of appropriate credit to candidates of modest achievement. Modular systems introduced in other institutions are sometimes so rigid as to make it impossible for weak students to obtain a degree. For this and many other reasons I hope that Cambridge will continue to resist the modularisation plague.*

2.6 Duty examiners

It is (we believe) Faculty policy that at least one examiner remains in the Mill Lane Lecture Rooms (where the examinations take place) for the duration of the examination. However, the invigilators announce at the beginning of each examination that the examiner will only be present for the first 30 minutes. It is very likely that this announcement deters candidates from seeking clarifications after 30 minutes, and may explain why some errors go uncorrected even though they have been spotted by candidates. We **recommend**

1. that the Chair of the Faculty Board refers to the faculty policy on attendance in the letter to Chairs of Examiners;
2. that the Board of Examinations be asked whether invigilators can be issued with an announcement appropriate for mathematics.

2.7 Invigilation

The Part IA examiners reported that one invigilator started the examination late, having used part of the examination time to make her opening statement. There were formal complaints from candidates who had lost about 5 minutes, and the examiners had to go to great trouble to make allowances for this in the classification of two candidates. We **recommend** the Board of Examinations be asked to instruct invigilators that a late start to an examination must be compensated exactly by a late finish.

³It would seem to us odd to give the 8α breakpoint greater prominence than the different weight accorded to alphas at each class boundary.

2.8 Deputy chair of examiners

Professor Moss (Part IB External) suggests that it would be useful to have a ‘chair elect of examiners’ each year who would work closely with the Chair of Examiners, becoming Chair in the subsequent year, to ensure better continuity. Professor Wilson (Part II External) makes the same suggestion; he suggests as an alternative that the Chair should take on the job for three years rather than one.

Clearly there would be practical difficulties in implementing this suggestion (connected with sabbatical leave, for example). However, we thought that it has merit. We also saw an advantage for the Chair in working together with a colleague for some of the more technical tasks.⁴ We therefore **recommend** that the Faculty Board consider appointing a Deputy Chair of Examiners for each Part of the Tripos. The Deputy Chair would collaborate with the Chair in all aspects of the administration of the examination and would ideally (though probably not always) chair the examination in the following year.

2.9 Comments on questions by external examiners

The Part II Examiners recommend that each suggestion by an External Examiner receive a reply stating that the suggestion has been implemented or giving a reason for not doing so. They suggest that the process might be facilitated by the provision of a form. We **recommend** that the Faculty Board consider taking the recommendation of the Part II examiners forward.

2.10 Marking conventions

Professor Moss (Part IB External) reiterates his suggestion that examiners put a red vertical line on pages they have seen. We do not think it necessary to be so prescriptive. Clearly, there should be some sort of red mark on each marked page, and mark checkers are required to draw to their examiner’s attention any page with no red mark. We note that these instructions are included in the letter from the Chair of the Faculty Board to the Chairs of the Examiners.

The Part IB External Examiners also comment on the fact that some examiners did not use sub-totals for parts of questions and ticks/crosses for correct/incorrect answers, while Professor Greenlees (Part IB External) notes that it is very difficult for external examiners to check the accuracy and consistency of marking without detailed up-to-date marking schemes. Professor Young (Part II External) makes a similar point. We note that examiners are asked, in the letter from the Chair of the Faculty Board to Chairs of Examiners, to do precisely this, with the exception of the word ‘detailed’.

Last year, Faculty Board agreed our recommendation that the letter from the Chair of the Faculty Board be sent directly to all examiners and not just the chairs. It is not clear that this happened. Hence, we **recommend** that the letter be redesignated as a letter from the Chair of the Faculty Board to Examiners. We also **recommend** that the material in this letter be re-ordered, because some is aimed at the Chairman specifically and some is aimed at all examiners.

2.11 Timetable for setting

Several External Examiners point out the importance of agreeing a timetable for the setting process, making it known to the examiners and sticking to it. We make no recommendation since the examiners will see this report.

2.12 Faculty Secretary and Computer Officer

All the Examiners’ reports remarked on the excellent support given by the staff of the Faculty Office, and in particular by Amy Moir. We **recommend** that the Chair of the Faculty Board expresses the appreciation

⁴For example, we understand that a vital but complicated checking procedure was not carried out effectively in Part IB necessitating a further meeting of examiners later in the summer to consider a number of candidates some of whose marks had been muddled with those of other candidates. The result was that one candidate was placed in a higher class. We feel that this unfortunate slip might well not have occurred if a second examiner had been involved in the checking.

of the Board for their work.

The Examiners in all Parts of the Tripos found the expertise of Mike Rose, Chris Mortimer and John Sutton invaluable. We **recommend** that the Chair of the Faculty Board expresses the appreciation of the Board for their work.

3 Part IA

3.1 Examination structure

Professor Mansfield (External Examiner) raises, as last year, the possibility of having one paper per course (i.e. eight papers in total), to avoid specialisation *if this is an issue* (his words).

Our feeling was that specialisation is not an issue because nearly all students follow all courses throughout the year. Some students may focus on their strengths when it comes to revision (though it is difficult to tell whether they revise selectively or simply decide when it comes to the examination only to tackle questions on certain courses). We were not keen on an increase in the number of hours of examination or on a decrease in the length of examination papers.

We note that the question of modularisation was discussed at great length recently by the Faculty (see also comments of Professor Wilson earlier in this report), mainly in connection with Part II though many of the arguments apply to other parts of the Tripos. This resulted in the Faculty reaffirming its commitment to the existing non-modular system.

3.2 Differences in difficulty between questions

The Part IA examiners note that there was a considerable disparity in the alpha success rate between different courses (for example, for Dynamics & Relativity and Numbers & Sets it was about 0.39, and for Groups and Probability it was 0.65 and 0.60) and again between the pure and applied courses (0.55 and 0.44 respectively). Although there is no formal choice of courses in Part IA, some students (especially the weaker ones) may decide to focus their revision on a selection of courses, so this situation is rather unsatisfactory. We **recommend** that this year's examiners attempt to achieve a more balanced examination.

4 Part IB

4.1 Curriculum

Professor Moss (External Examiner) comments that there might be some scope for updating the syllabuses for Electromagnetism and Quantum Mechanics to reflect some of the developments over the last half century. We note that the courses in Part IB (which are at the level of final year courses at some universities) are intended as foundation courses for the courses in Part II which tackle the subject matter in more depth and (possibly) more modernity. We noted that it is difficult to teach more modern material in a rigorous way, which is the hall mark of the Tripos, without students having already achieved a good understanding of the foundations.

4.2 Relation between marks and quality marks

Professor Greenlees (External Examiner) proposes removing the direct link between marks and merit marks on the grounds that examiners sometimes ignore their mark scheme in the interests of justice. We discussed this interesting idea, but concluded that it would add additional variables 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.

4.3 Differences in difficulty between questions

Professor Moss (External) was concerned by the significant disparity between the pure and applied questions and between different courses. The alpha rates (on long questions) were as follows:

An II	CA	Geom	GRM	LA	Met&Top	Markov	Opt	Stat	CM	EM	FD	Meth	NA	QM	VP
0.56	0.44	0.77	0.84	0.58	0.41	0.71	0.64	0.67	0.75	0.36	0.41	0.64	0.60	0.30	0.63

The overall rate is 0.59. These figures should be compared with the historical average⁵ alpha rate of about 0.45 in Part IA and IB.

Clearly, these disparities (which could be due to the difficulty of the course, the difficulty of the questions or the harshness of the marking scheme) are undesirable, and we **recommend** that next year's examiners try to ensure that a better balance is achieved.

5 Part II

5.1 Variation in difficulty of courses

Professor Kerr (External) notes that the questions on some courses attracted high alpha rates but, on further investigation, that these questions had been attempted predominantly by candidates in the upper regions of the Tripos.

We looked at the bar chart showing the spread of raw marks on each question by course, and the chart showing the same data adjusted to remove the 'student effect', and noted that the two courses that seemed particularly out of line on the raw marks chart (Algebraic Geometry and Waves) did indeed appear more normal on the adjusted chart.

Professor Kerr wonders whether there is something about these courses that discourages weaker students. The Teaching Committee monitors the student responses, including the perceived difficulty, and makes recommendations (which may relate to the course or its delivery) when appropriate. We do not believe any action is required at the moment.

However, we **recommend** that the adjusted chart *with an explanation* be sent to all Part II lecturers so that they can judge their questions better and that this be alluded to in item 6 (first sentence) of the Chair of the Faculty Board's letter to Chairs of Examiners.

5.2 CATAM

The Part II Examiners comment that some Examiners (including one External Examiner) found some of the projects excessively long, and **recommend** that CPAC should consider whether a limit should be set on the length of projects.

Clive Newstead	Richard Samworth	Thanasis Fokas	Imre Leader	
David Mestel	John Lister	David Tong	Tom Fisher	Stephen Siklos (Chair)

November 10, 2011

⁵For Part IA for the years 2003 to 2011, the overall alpha rates are 0.41, 0.45, 0.44, 0.48, 0.38, 0.45, 0.40, 0.53, 0.49. For Part IB, the corresponding figures are 0.39, 0.46, 0.35, 0.39, 0.47, 0.40, 0.38, 0.47, 0.59. For Part II 2005 (before which the Tripos was split into Alternatives A and B) to 2011, the figures are 0.46, 0.52, 0.46, 0.49, 0.45, 0.52, 0.51. The increase in alpha rate in Part II compared with Parts IA and IB may reflect the high quality of teaching received by our students over their three years (cf A-level grades).