

FHS Mathematics and Statistics Part C 2011

Examiners' Report

Part I

A. Statistics

1. Numbers and percentages in each class

The figures in Table 1 are for Mathematics and Statistics. For comparison, Table 2 gives the corresponding figures for Mathematics.

Class	Number				Percentage			
	2011	2010	2009	2008	2011	2010	2009	2008
1	8	(3)	(10)	(7)	33.3	(25)	(50)	(50)
2(i)	9	(8)	(6)	(3)	37.5	(66.7)	(30)	(21.4)
2(ii)	4	(0)	(2)	(2)	16.7	(0)	(10)	(14.3)
3	3	(1)	(2)	(2)	12.5	(8.3)	(10)	(14.3)
Fail	0	(0)	(0)	(0)	0	(0)	(0)	(0)
Total	24	(12)	(20)	(14)	100	(100)	(100)	(100)

Table 1: Numbers and percentages of Mathematics and Statistics candidates in each class.

Class	Number				Percentage			
	2011	2010	2009	2008	2011	2010	2009	2008
1	47	(49)	(48)	(44)	46.5	(46.2)	(50.5)	(46.3)
2(i)	37	(37)	(30)	(45)	36.6	(34.9)	(31.6)	(47.4)
2(ii)	14	(15)	(13)	(6)	13.9	(14.2)	(13.7)	(6.3)
3	1	(5)	(3)	(0)	1.0	(4.7)	(3.2)	(0)
Fail	2	(0)	(1)	(0)	2.0	(0)	(1.1)	(0)
Total	101	(106)	(95)	(95)	(100)	(100)	(100)	(100)

Table 2: Numbers and percentages of Mathematics candidates in each class.

2. Vivas

There are no vivas in Mathematics and Statistics.

3. Marking of scripts

Number of scripts double-marked: 24 dissertations and 29 mini-projects. The remaining scripts were single-marked according to detailed pre-agreed mark schemes. The checking process for scripts and mark entry was the same as that used as in all parts of Mathematics/Mathematics and Statistics (see Part II, Section A).

B. New examining methods and procedures

None.

C. Suggested changes in examining methods and procedures

None.

D. Notice of examination conventions to candidates

Candidates were given details of the examining conventions in the Notices to Candidates that were sent out by the Examiners. These notices also reminded candidates about the department's Examination Conventions document.

Part II

A. General comments on the examination

1. The internal examiners record their thanks to:
 - the external examiners, Professor Penrose (Statistics external) and Professor Vickers (Mathematics external)
 - all assessors
 - the administrative staff of the Department of Statistics, particularly Jan Boylan, and the Mathematical Institute administrative staff
 - Waldemar Schlackow for managing the exam database
 - the graduate students who acted as checkers for the scripts and mark entry.
2. For written exams, course lecturers acted as assessors. They provided draft questions, which were then considered by nominated checkers before questions were considered by the examiners. Lecturers also marked the questions on their courses. Mark processing and checking was carried out according to the usual procedures: scripts were checked to ensure that all work had been marked and that all marks had been correctly totalled and recorded. In this way a small number of errors were corrected and each change was signed-off by one of the examiners.
3. For each mini-project, the course lecturer acted as an assessor, and provided a draft of the mini-project. The statistics internal examiners acted as the checkers of mini-projects.
4. The external examiners scrutinised the draft questions/mini-projects and provided helpful input which was incorporated into the final versions. (The Statistics external looked at the questions/mini-projects on statistics courses, the Mathematics externals looked at the questions on mathematics courses.)
5. All dissertations and mini-projects were independently double-marked. When the two marks showed minor discrepancies, the two marks were averaged, in the other cases a mark was agreed after a discussion between the markers.
6. For both Parts B and C this year, in common with Mathematics, instructions to setters were rewritten in an attempt to ensure that there was sufficient basic/straightforward material on which weaker candidates in particular could gain marks. We think this was successful and recommend similar instructions be used for 2012.
7. We had the largest cohort ever for Mathematics and Statistics Part C this year – 24 students. As usual the Examiners paid close attention to the combined cohort of Mathematics, and Mathematics and Statistics candidates, in the mark-scaling discussions on day 1 of the Final Examiners' Meeting. (The starting point for

these discussions was an initial scaling, described below, based on the combined cohort.) Although the results profile of Mathematics and Statistics candidates shows fluctuations from year to year, once combined with the Mathematics cohort the corresponding profile is fairly stable. On day 2 of the final meeting the Examiners considered in detail all candidates near borderlines and made a small number of final changes in order to arrive at a class list which, in their academic judgement, was in line with the candidates' performance.

Determination of University Standardised Marks

The marks reported to candidates are University Standardised Marks (USMs). Mini-projects and dissertations were marked to the USM scale – the scaling process described below was not used for these marks.

Raw marks from written exams were converted to USMs by scaling, each half-unit being scaled separately to allow for differences in difficulty. For the purpose of determining the scaling, Mathematics, and Mathematics and Statistics candidates, are not distinguished, they are treated as a single cohort. The algorithm used to provide a starting point for the Examiners' deliberations on scaling is as follows. It uses the weighted average USM from Parts A+B.

The initial map from raw mark r to USM has four segments. Suppose that for some particular half-unit, n_{70} (n_{60}) of the candidates had a USM of 70 (60) or above in Parts A+B. Then a USM of 70 (60) is set at the raw mark, r_{70} (r_{60}) say, of the n_{70} 'th (n_{60} 'th) ranked candidate on that half-unit. Take the straight line through the two points $(r_{60}, 60)$ and $(r_{70}, 70)$ and truncate it at points P_1 and P_2 where it meets the lines $USM = 72$ and $USM = 57$ respectively. A line segment joins P_1 to $(50, 100)$, and another joins P_2 to $(0, 20)$. But the latter segment is broken, at P_3 , where it intersects the line $USM = 37$, and the final segment of the map is from P_3 to $(0, 0)$. So the initial map from raw mark r to USM is the four segments joining $(0, 0)$, P_3 , P_2 , P_1 , $(50, 100)$. (Note that the raw mark for a half-unit is out of a maximum of 50, while the USM is scaled to a maximum of 100.)

A main item of business for day 1 of the Final Examiners' Meeting is to consider the maps for each half-unit and make changes where necessary. Usually these changes are made by adjusting the position of the points P_1 , P_2 , P_3 by hand so as to produce a fair map for each paper. To do all half-units, on mathematics and statistics, usually takes most of the day. A preliminary meeting, earlier in the week of the final meeting, had considered and modified many of the initial maps to provide a starting point for the discussions on day 1 of the final meeting.

For a well-set paper taken by a large number of candidates, the algorithm yields a piecewise linear map which is close to linear, usually with a somewhat steeper first and last segment. Assessors had been asked to include in their reports an opinion of the value of the marks achieved in terms of classification. The adjustments made were based on inspection of the scripts, assessors' reports, the judgement of examiners, and of course the advice of the External Examiners.

The final positions of P_1 , P_2 , P_3 for statistics half-units and for mathematics half-units taken by at least two Mathematics and Statistics candidates are given in Table 3 below. For the corresponding information for the remaining mathematics units/half-units see the Examiners' Report on Mathematics Part C.

Paper	P_3	P_2	P_1
MS1a	(15.3, 37)	(31, 57)	(41, 72)
MS2b	(16.4, 37)	(27, 57)	(44, 70)
C6.3a	(10.6, 37)	(23, 57)	(39, 72)
C8.1b	(11.9, 37)	(26, 57)	(41, 72)
C11.1a	(9.0, 37)	(19, 57)	(42.5, 72)
C11.1b	(11.6, 37)	(25.3, 57)	(41, 72)
C12.1a	(9.0, 37)	—	(42, 72)

Table 3: The points P_1 , P_2 , P_3 used for scaling.

Table 4 gives the rank of candidates by average USM in Part C.

Av USM	Rank	Candidates with this USM or higher	%
79	1	1	4.2
77	2	3	12.5
74	4	5	20.8
73	6	6	25
70	7	8	33.3
69	9	9	37.5
68	10	10	41.7
65	11	11	45.8
63	12	13	54.2
62	14	14	58.3
61	15	16	66.7
60	17	17	70.8
59	18	18	75
57	19	19	79.2
56	20	20	83.3
54	21	21	87.5
49	22	23	95.8
47	24	24	100

Table 4: Number and percentage of candidates scoring a given USM or higher.

B. Equal opportunities issues and breakdown of the results by gender

Table 5 shows the numbers of male and female candidates in the various classes. Female candidates outnumbered male candidates this year, and achieved slightly better results.

Class	Female	Male
1	4	4
2(i)	9	0
2(ii)	2	2
3	0	3
Fail	0	0

Table 5: Breakdown of results by gender.

C. Detailed numbers on candidates' performance in each part of the examination

The performance of candidates is summarised in Tables 6 and 7. Only units/half-units with at least two Mathematics and Statistics candidates are included in Table 6.

Paper	Number of candidates	Av RAW	StDev RAW	Av USM	StDev USM
MS1a	21	34.33	9.17	64.38	15.66
MS2b	10	41.5	5.13	71.4	11.42
C6.3a	8	21.25	7.74	52.62	9.65
C8.1b	4	29.75	11.95	59.5	14.2
C11.1(1)	7	19.57	10.44	52.29	11.84
C11.1(2)	6	27.5	11.59	56.5	14.94
C11.1a	10	30	9.49	64	9.25
C12.1a	2	21	12.73	49.5	13.44

Table 6: Summary of written exam half-units: Mathematics and Statistics candidates only. Note that these marks are for half-units, so raw marks are out of a maximum of 50, while the USMs are scaled to a maximum of 100. The additional numbers of Mathematics candidates taking MS1a and MS2b were 8 and 10 respectively. (C11.1(1) and C11.1(2) refer to the first and second halves of C11.1 for candidates taking the full unit C11.1.)

USM	Number of candidates		
	MS1b	MS2a	Dissertation
70–100	7	3	10
60–69	15	0	10
50–59	3	1	3
40–49	0	0	1
0–39	0	0	0

Table 7: Summary of mini-projects and dissertations: MS1b and MS2a numbers include Mathematics, and Mathematics and Statistics candidates; dissertations are Mathematics and Statistics candidates only. (The numbers of Mathematics and Statistics candidates taking MS1b and MS2a were 20 and 3 respectively, and the numbers of Mathematics candidates were 5 and 1 respectively.)

For Mathematics and Statistics candidates only, the following tables give detailed question data for each statistics paper.

Paper MS1a Graphical Models and Inference

Question	Average mark		StDev	Number of attempts	
	All	Used		Used	Unused
Q1	15.94	16.58	4.42	17	2
Q2	14.36	18.42	8.57	7	4
Q3	17.21	17.22	5.17	18	1

(Average marks for Maths candidates: Q1 17, Q2 15.8, Q3 21.57)

Paper MS2b Stochastic Models in Mathematical Genetics

Question	Average mark		StDev	Number of attempts	
	All	Used		Used	Unused
Q1	14.4	19	5.50	2	3
Q2	22.2	22.2	2.39	10	0
Q3	19.37	19.37	4.03	8	0

(Average marks for Maths candidates: Q1 19.33, Q2 20.5, Q3 20.22)

D. Comments on papers and individual questions

The following comments on statistics papers were submitted by assessors; for comments on mathematics papers, see the Examiners' Report on Mathematics Part C. The com-

ments relate to all candidates taking these papers, not just Mathematics and Statistics candidates.

MS1a Graphical Models and Inference

Q1 and Q3 were both attempted by 26 students whereas Q2 were only attempted by 14 students, possibly because this question was most different from questions from previous years. All questions had several solution attempts giving above 20 points, so seem to have been doable by students who have followed the course seriously.

MS2b Stochastic Models in Mathematical Genetics

Q1: This was a question on coalescent theory, with a section on examining coalescence times with a changing population size. Perhaps because this material is historically rather rarely examined, this was less popular than the other two questions and some candidates attempted it as a third question, and did not get to the end due to lack of time. Those who made serious attempts generally achieved decent results, > 13 marks, with some candidates achieving full marks. The first few parts had a high standard of answer, especially the bookwork parts, although some struggled to write down the expected number of segregating sites in the general case. Candidates lost marks mainly on the later parts, with a steady decline in completeness of answers as the question went on. Those candidates who struggled at the end also struggled with the second piece of bookwork, regarding the distribution of coalescence times in a changing population. The penultimate part on obtaining an explicit time while j ancestors (answered by first considering sums of times) proved too challenging for some, particularly those not strong in probability, and these candidates then tended not to answer the very final part, with many overcomplicating things here (it is really enough to show that the time while n ancestors dominates).

Q2: This question covered the frequency distribution of mutations, and also basic diffusions probabilities including the fixation probability for neutral mutations. It covered material quite familiar to candidates from lectures, and perhaps for this reason was very popular, attempted by all candidates, with an excellent standard of answer, and all attempts gaining at least 13 marks with several gaining 25/25. On the whole, candidates showed an excellent understanding of the material, with most errors down to either slips, or sloppy notation. The parts asking about the distribution of descendants in the coalescent were particularly well answered. However, some candidates did struggle with deriving the probability a mutation happens while k lineages remain, in part (c), by not properly conditioning on times in the coalescent tree. In general a few candidates gave insufficient detail for this part. Some candidates also made errors in the diffusion theory part of the question, e.g. sloppiness in the fixation probability proof, and a few failed to solve the final d.e. to obtain x as the fixation probability.

Q3: This was a question on drawing trees and inferring recombination history using variation data. Although not as popular as question 2, it still saw a large number of attempts and similarly to that question was overall very well answered, with a number

of 25/25 answers and most candidates obtaining > 16 marks. Slips were though made throughout, some revealing errors of understanding but often simple lack of detail given. Common mistakes included not explaining the haplotype bound fully, e.g. where the “1” comes from in $H - S - 1$, or claiming falsely that all ancestral mutations increase the number of types in a sample. Most candidates perfectly constructed the gene tree, which gave at least 8 marks, and most did the bookwork parts well, although for example marks were lost due to not explaining the issue of “togglng” in (a)(ii). Some candidates used the four-gamete test for the final part, gaining no credit for this – though the majority of answers were correct here.

E. Comments on the performance of identifiable individuals and other material which would usually be treated as reserved business

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F. Names of members of the Board of Examiners

Examiners: Dr K Hannabuss, Dr CN Laws (Chairman), Dr GK Nicholls, Prof MD Penrose (External), Dr D Stirzker, Prof JAG Vickers (External).

Assessors for MS1a–MS2b and dissertations: Dr O Burke, Dr D Clarke, Prof JJ Hein, Prof SL Lauritzen, Dr R Lyngsø, Dr J Marchini, Dr S Massa, Dr NF Meinshausen, Dr SR Myers, Dr DR Steinsaltz, Dr M Winkel.

28-09-2010