Examiners' Report:
Final Honour School of Mathematics Part A
Trinity Term 2025

May 26, 2026

Part I

A. STATISTICS

- **Numbers and percentages in each class.**
  See Table 1.

Table 1: Numbers in each class

Range	Numbers				Percentages %			
	2025	(2024)	(2023)	(2022)	2025	(2024)	(2023)	(2022)
70–100	50	(44)	(44)	(59)	34.97	(34.59)	(30.77)	(36.65)
60–69	66	(64)	(67)	(71)	46.15	(48.12)	(46.85)	(44.1)
50–59	19	(22)	(25)	(22)	13.29	(16.54)	(17.48)	(13.66)
40–49	-	(-)	(-)	(-)	-	(-)	(-)	(-)
30–39	-	(-)	(-)	(-)	-	(-)	(-)	(-)
0–29	-	(-)	(-)	(-)	-	(-)	(-)	(-)
Total	143	(133)	(143)	(161)	100	(100)	(100)	(100)

- **Numbers of vivas and effects of vivas on classes of result.**
  Not applicable.
- **Marking of scripts.**
  All scripts were single marked according to a pre-agreed marking scheme which was strictly adhered to. The raw marks for paper A2 are out of 100, and for the other papers out of 50. For details of the extensive checking process, see Part II, Section A.
- **Numbers taking each paper.**
  All 143 candidates are required to offer the core papers A0, A1, A2 and ASO, and five of the optional papers A3-A11. Statistics for these papers are shown in Table 2 on page .

Table 2: Numbers taking each paper

Paper	Number of Candidates	Avg RAW	StDev RAW	Avg USM	StDev USM
A0	143	32.16	8.63	63.86	14.74
A1	143	34.97	7.62	67.17	11.79
A2	142	68.06	14.61	65.83	10.44
A3	77	35.74	10.55	66.22	16.7
A4	127	24.66	9.08	65.13	9.77
A5	92	31.6	9.45	64.14	13.32
A6	91	32.66	8.1	65.6	9.93
A7	48	34.46	8.74	66.04	12.19
A8	137	32.18	7.58	66.35	10.6
A9	89	34.58	10.79	66.49	14.53
A10	33	33.76	8.92	64.42	10.78
A11	29	31.9	8.43	64.66	10.84
ASO	143	35.59	8.14	66.01	12.08
A2 OR	-	-	-	-	-

B. New examining methods and procedures

None.

C. Changes in examining methods and procedures currently under discussion or contemplated for the future

None.

D. Notice of examination conventions for candidates

The first notice to candidates was issued on the 25th February 2025 and the second notice on the 14th May 2025.

These can be found at `https://www.maths.ox.ac.uk/members/students/undergraduate-courses/ba-master-mathematics/examinations-assessments/examination-20`, and contain details of the examinations and assessments. The course handbook contains the link to the full examination conventions and all candidates are issued with this at induction in their first year. All notices and examination conventions are online at `https://www.maths.ox.ac.uk/members/students/undergraduate-courses/examinations-assessments/examination-conventions`.

Part II

A. General Comments on the Examination

Acknowledgements

- Clare Donnelly for her work in supporting the Part A examinations throughout the year, and for her help with various enquiries throughout the year.
- Waldemar Schlackow and Matt Brechen for running the database and the algorithms that generate the final marks, without which the process could not operate.
- Charlotte Turner-Smith and Rosalind Mitchell for their help and support, together with the Academic Administration Team, with marks entry, script checking, and much vital behind-the-scenes work.
- The assessors who set their questions promptly, provided clear model solutions, took care with checking and marking them, and met their deadlines, thus making the examiners' jobs that much easier.
- Several members of the Faculty who agreed to help the committee in the work of checking the papers set by the assessors.
- The internal examiners and assessors would like to thank the external examiners, Prof Ali Taheri and Prof Mark Blyth, for helpful feedback and much hard work throughout the year, and for the important work they did in Oxford in examining scripts and contributing to the decisions of the committee.

Timetable

The examinations began on Monday 16th June and ended on Friday 27th June.

Mitigating Circumstances Notices to Examiners

A subset of the examiners (the 'Mitigating Circumstances Panel') attended a pre-board meeting to band the seriousness of the individual notices to examiners. The outcome of this meeting was relayed to the Examiners at the final exam board, who gave careful regard to each case, scrutinised the relevant candidates' marks and agreed actions as appropriate.

Setting and checking of papers and marks processing

As is usual practice, questions for the core papers A0, A1 and A2, were set by the examiners and also marked by them with the assistance of assessors. The papers A3-A11, as well as each individual question on ASO, were set and marked by the course lecturers/assessors. The setters produced model answers and marking schemes led by instructions from Teaching Committee in order to minimize the need for recalibration.

The internal examiners met in December to consider the questions for Michaelmas Term courses (A0, A1, A2 and A11). The course lecturers for the core papers were invited to comment on the notation used and more generally on the appropriateness of the questions. Corrections and modifications were agreed by the internal examiners and the revised questions were sent to the external examiners.

In a second meeting the internal examiners discussed the comments of the external examiners and made further adjustments before finalising the questions. The same cycle was repeated in Hilary term for the Hilary term long option courses and at the end of Hilary and beginning of Trinity term for the short option courses. *Papers A8 and A9 are prepared by the Department of Statistics and jointly considered in Trinity term.* Before questions were submitted to the Examination Schools, setters were required to sign off on a camera-ready copy of their questions.

The whole process of setting and checking the papers was managed digitally on SharePoint. Examiners adopted specific and detailed conventions to help with version checking and record keeping.

Examination scripts were collected by the markers from Exam Schools or delivered to the Mathematical Institute for collection by the markers and returned there after marking. A team of graduate checkers under the supervision of Hannah Ross, Rosalind Mitchell and Charlotte Turner-Smith sorted all the scripts for each paper, cross-checking against the mark scheme to spot any unmarked questions or part of questions, addition errors or wrongly recorded marks. Also sub-totals for each part were checked against the marks scheme, noting any incorrect addition.

Determination of University Standardised Marks

The examiners followed the standard procedure for converting raw marks to University Standardized Marks (USM). The raw marks are totals of marks on each question, the USMs are statements of the quality of marks on a standard scale. The Part A examination is not classified but notionally 70 corresponds to 'first class', 50 to 'second class' and 40 to 'third class'. In order to map the raw marks to USMs in a way that respects the qualitative descriptors of each class the standard procedure has been to use a piecewise linear map. It starts from the assumption that the majority of scripts for a paper will fall in the USM range 57-72, which is just below the II(i)/II(ii) borderline and just above the I/II(i) borderline respectively. In this range the map is taken to have a constant gradient and is determined by the corners C_1 and C_2, which encode the raw marks corresponding to a USM of 72 and 57 respectively. The guidance requires that the examiners should use the entire range of USMs. Our procedure interpolates the map linearly from C_1 to $(M, 100)$ where M is the maximum possible raw mark. In order to allow for judging the position of the II(i)/III borderline on each paper, which corresponds to a USM of 40, the map is interpolated linearly between C_3 and C_2 and then again between $(0, 0)$ and C_3. Thus, the conversion of raw marks to USMs is fixed by the choice of the three corners C_1, C_2 and C_3. While the default y-values for these corners were given above and are not on the class borderlines, the examiners may opt to change those default values, e.g., to avoid distorting marks around class boundaries. The final choice of the scaling parameters is made by the examiners, guided by the advice from the Teaching Committee, considering the distribution of the raw marks and examining individuals on each paper around the borderlines.

The final resulting values of the parameters that the examiners chose are listed in Table 3.

Table 4 gives the resulting final rank and percentage of candidates with this overall average USM (or greater).

Table 3: Parameter Values

Paper	C1	C2	C3
A0	12.87;37	22.4;57	40.4;72
A1	14.94;37	26;57	42;72
A2	29.3;37	51;57	81;72
A3	14.99;37	26.1;57	43;70
A4	7.35;37	12.8;57	33.8;72
A5	11.95;37	20.8;57	41.8;72
A6	12.7;37	22.1;57	41.6;72
A7	13.67;37	23.8;57	42;70
A8	12.29;37	21.4;57	39.4;72
A9	12.01;37	20.9;57	43;70
A10	13.84;37	24.1;57	43.6;72
A11	12.7;37	22.1;57	41.6;72
A12	11.66;37	20.3;57	33.8;72
ASO	15.34;37	26.7;57	43.2;72

Table 4: Rank and percentage of candidates with this overall average USM (or greater)

Av USM	Rank	Candidates with this USM or above	%
91.8	1	1	0.7
86.9	2	2	1.4
85.33	3	3	2.1
85.1	4	4	2.8
83.7	5	5	3.5
81.7	6	7	4.9
81.7	6	7	4.9
81.2	8	8	5.59
81	9	9	6.29
80.4	10	10	6.99
79.5	11	11	7.69
77.3	12	12	8.39
77.2	13	13	9.09
76.95	14	14	9.79
76.9	15	15	10.49
76.8	16	17	11.89
76.8	16	17	11.89
76.3	18	18	12.59
76	19	19	13.29
75.9	20	20	13.99
75.7	21	22	15.38
75.7	21	22	15.38
74.8	23	24	16.78
74.8	23	24	16.78

Table 4: Rank and percentage of candidates with this overall average USM (or greater) [continued]

Av USM	Rank	Candidates with this USM or above	%
74.3	25	25	17.48
74	26	26	18.18
73.9	27	27	18.88
73.4	28	28	19.58
72.6	29	29	20.28
72.4	30	30	20.98
71.9	31	31	21.68
71.6	32	32	22.38
71.5	33	34	23.78
71.5	33	34	23.78
71.3	35	36	25.17
71.3	35	36	25.17
71.2	37	37	25.87
71.1	38	38	26.57
70.7	39	39	27.27
70.4	40	42	29.37
70.4	40	42	29.37
70.4	40	42	29.37
70.35	43	43	30.07
70.2	44	44	30.77
70.1	45	46	32.17
70.1	45	46	32.17
70	47	47	32.87
69.8	48	49	34.27
69.8	48	49	34.27
69.5	50	50	34.97
69.4	51	54	37.76
69.4	51	54	37.76
69.4	51	54	37.76
69.4	51	54	37.76
69.3	55	56	39.16
69.3	55	56	39.16
68.7	57	57	39.86
68.5	58	58	40.56
68.3	59	59	41.26
68.2	60	61	42.66
68.2	60	61	42.66
68	62	62	43.36
67.3	63	63	44.06
67	64	64	44.76
66.9	65	66	46.15
66.9	65	66	46.15

Table 4: Rank and percentage of candidates with this overall average USM (or greater) [continued]

Av USM	Rank	Candidates with this USM or above	%
66.7	67	68	47.55
66.7	67	68	47.55
66.6	69	69	48.25
66.4	70	70	48.95
66.2	71	71	49.65
65.9	72	72	50.35
65.8	73	74	51.75
65.8	73	74	51.75
65.5	75	75	52.45
65.3	76	76	53.15
65.1	77	77	53.85
64.9	78	78	54.55
64.7	79	79	55.24
64.6	80	81	56.64
64.6	80	81	56.64
64.5	82	83	58.04
64.5	82	83	58.04
64.33	84	84	58.74
64.2	85	85	59.44
64.1	86	86	60.14
64	87	87	60.84
63.7	88	89	62.24
63.7	88	89	62.24
63.67	90	90	62.94
63.6	91	91	63.64
63.5	92	93	65.03
63.5	92	93	65.03
63.3	94	94	65.73
63.2	95	95	66.43
62.9	96	96	67.13
62.7	97	97	67.83
62.6	98	98	68.53
62.5	99	99	69.23
62.4	100	100	69.93
61.9	101	101	70.63
61.89	102	102	71.33
61.7	103	104	72.73
61.7	103	104	72.73
61.6	105	105	73.43
61.4	106	106	74.13
61.25	107	107	74.83
61.1	108	108	75.52

Table 4: Rank and percentage of candidates with this overall average USM (or greater) [continued]

Av USM	Rank	Candidates with this USM or above	%
60.8	109	109	76.22
60.6	110	110	76.92
60.4	111	111	77.62
60.3	112	112	78.32
60	113	113	79.02
59.9	114	114	79.72
59.8	115	115	80.42
59.5	116	116	81.12
58.9	117	117	81.82
58.1	118	118	82.52
58	119	119	83.22
57.75	120	120	83.92
57.7	121	121	84.62
57.6	122	122	85.31
57.4	123	124	86.71
57.4	123	124	86.71
57.3	125	125	87.41
57	126	126	88.11
56.6	127	127	88.81
56.11	128	128	89.51
56.1	129	129	90.21
54.4	130	130	90.91
54.22	131	131	91.61
54.1	132	132	92.31
53.5	133	133	93.01
51.6	134	134	93.71
50.7	135	135	94.41
49.33	136	136	95.1
49.1	137	137	95.8
47	138	138	96.5
45.1	139	139	97.2
44.9	140	140	97.9
43.8	141	141	98.6
39.5	142	142	99.3
33.56	143	143	100

B. Equality and Diversity issues and breakdown of the results by gender

Table 5, page shows percentages of male and female candidates for each class of the degree.

Table 5: Breakdown of results by gender

Class	Number								
	2025			2024			2023		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
70–100	7	43	50	8	38	46	-	40	44
60–69	18	48	66	16	48	64	19	48	67
50–59	10	9	19	10	12	22	11	14	25
40–49	-	-	-	-	-	-	-	-	-
30–39	-	-	-	-	-	-	-	-	-
0–29	-	-	-	-	-	-	-	-	-
Total	36	107	143	35	98	133	39	105	144
Class	Percentage								
	2025			2024			2023		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
70–100	19.44	40.19	34.97	22.86	38.78	34.59	-	38.46	30.77
60–69	50	44.86	46.15	45.71	48.98	48.12	48.72	46.15	46.85
50–59	27.78	8.41	13.29	28.57	12.24	16.54	28.21	13.46	17.48
40–49	-	-	-	-	-	-	-	-	-
30–39	-	-	-	-	-	-	-	-	-
0–29	-	-	-	-	-	-	-	-	-
Total	100	100	100	100	100	100	100	100	100

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

Individual question statistics for Mathematics candidates are shown in the tables below.

Paper A0: Linear Algebra

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	19.04	19.04	5.03	118	0
Q2	14.02	14.25	5.2	53	1
Q3	13.56	13.77	4.39	109	4

Paper A1: Differential Equations 1

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	16.19	16.67	4.79	60	2
Q2	19.78	19.92	4.19	133	1
Q3	14.43	14.53	6.06	93	1

Paper A2: Metric Spaces and Complex Analysis

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	18.04	18.37	5.31	103	3
Q2	19.02	19.02	4.87	129	0
Q3	19.94	19.94	3.99	51	0
Q4	16.47	16.52	3.91	138	1
Q5	13.4	13.52	4.51	126	5
Q6	12.85	16.74	7.26	19	8

Paper A3: Rings and Modules

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	14.49	15.06	5.62	36	3
Q2	18.16	18.37	5.41	68	1
Q3	19.22	19.22	6.23	50	0

Paper A4: Integration

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	10.22	11.32	6.34	60	9
Q2	12.22	12.66	5.32	98	6
Q3	12.54	12.62	4.13	96	1

Paper A5: Topology

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	14.62	14.62	4.62	76	0
Q2	16.48	16.48	5.46	84	0
Q3	17.32	17.32	4.74	22	0

Paper A6: Differential Equations 2

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	17.26	17.26	3.97	84	0
Q2	14.05	15.66	6.97	35	6
Q3	14.72	15.46	5.62	63	6

Paper A7: Numerical Analysis

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	17.09	17.53	5.1	32	1
Q2	18.04	18.38	5.04	45	1
Q3	14	14	6.07	19	0

Paper A8: Probability

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	17.81	17.95	4.2	128	2
Q2	12.83	13.22	5.01	49	4
Q3	15	15.06	3.72	95	1

Paper A9: Statistics

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	14.07	14.16	6.43	43	2
Q2	16.6	16.73	6.03	71	1
Q3	19.5	20.02	5.6	64	2

Paper A10: Fluids and Waves

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	13.52	14	4.11	20	1
Q2	18.48	18.48	6.1	31	0
Q3	16.81	17.4	4.45	15	1

Paper A11: Quantum Theory

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	16.04	16.04	2.49	26	0
Q2	14.96	15.44	6.94	27	1
Q3	16.67	18.2	7.5	5	1

Paper ASO: Short Options

Question	Mean Mark		Std Dev	Number of attempts	
	All	Used		Used	Unused
Q1	17.48	17.48	4.07	46	0
Q2	16.37	16.96	5.08	28	2
Q3	20.91	21.05	4.06	22	1
Q4	18.32	18.56	4.87	85	2
Q5	16.28	16.83	6.9	24	1
Q6	16.57	16.57	4.47	47	0
Q7	17.26	17.26	4.77	34	0

D. Comments on papers and on individual questions

The following comments were submitted by the assessors.

Core Papers

A0: Algebra 1

Question 1 There were many excellent answers to this more computational question, with a large number of candidates scoring ≥ 20 out of 25. The final computation of the minimal and characteristic polynomials for an 'anti-diagonal' matrix was found easier than expected; some candidates may have seen this example before. Overall candidates showed an impressive ability to calculate in dual vector spaces. One very common error was to write down a characteristic polynomial of degree d for the operator T on a $(d+1)$-dimensional space.

Question 2 The bookwork part of this question, on the spectral theorem for unitary operators, was done well by most candidates attempting the question. Apart from occasional confusions between the notions of non-degenerate and positive definite forms, the first half of part (b) was also done well. As expected, the final two question parts were found more challenging. Many candidates claimed that the set of matrices U defined in (b)(iii) were the unitary matrices, even though the form $\langle \cdot, \cdot \rangle$ considered is not the standard dot product (and in fact is not even an inner product). Another common mistake was to claim that if a particular Jordan normal form matrix J is not in U, then there can be no matrix in U with that Jordan normal form.

Question 3 Candidates generally got the definition of the minimal polynomial in (a) correctly, and most of them also checked it is well-defined. A common mistake was to define the minimal polynomial in terms of a matrix, and show that this is independent of the choice of basis, which was not the point of the question.

Part (b)(i) was also bookwork and was completed by most of the candidates. Some of them forgot to check T-invariance or to compute the minimal polynomials. In part (b)(ii), most attempts checked that the image of $f(T)$ is T-invariant and hence T descends to a map on the quotient, but computing the minimal polynomial was found more difficult. The most successful attempt was simply recognizing that $f(\overline{T}) = 0$, so $m_{\overline{T}}(x)|f(x)$, but it was very common for students to forget to check that $m_{\overline{T}}(x) \neq 1$, i.e. $V \neq \mathrm{im} f(T)$.

Finally, part (c) was found difficult by the candidates. In part (c)(i), common alternative solutions included the cyclic permutation matrix and a matrix with all 1s above and on the diagonal. However, the most common answes were $\begin{pmatrix} 1 & 1 & 0 & \cdots & 0 \\ & 1 & 0 & \cdots & 0 \\ & & \ddots & & \\ & & & 1 & 0 \\ & & & & 1 \end{pmatrix}$ and $\begin{pmatrix} 1 & 0 & 0 & \cdots & 1 \\ & 1 & 0 & \cdots & 0 \\ & & \ddots & & \\ & & & 1 & 0 \\ & & & & 1 \end{pmatrix}$. Both of the latter matrices actually have minimal polynomial $(x-1)^2$

which divides $(x-1)^p = x^p - 1$. I think the mode for (c)(ii) was 0/5 and there were very few correct attempts in general.

A1: Differential Equations 1

Question 1 This is not so standard question on the core and central theoretical result on Picard's iteration of solving ordinary differential equations. Part (a) is a book work, and an example (or similar) should be seen in the lectures. Still few candidates failed to recognize the reason why the standard theorem on the existence of solutions can not applied, but most of those attempted did quite well. Part (b) is about Picard iteration showing the existence by using the monotone convergence theorem in place of Cauchy's principle as for the Lipschitz case. In this sense this part is new, but the steps(i-iv) designed carefully should easy the arguments the candidate need to work through. However, even under the uniform convergence of the iteration sequence, still a few of those we did this question failed to prove the limit of the iteration sequence is a solution. Part (c) is new, and should argue by contradiction, and received few good solutions to this part. Most of those attempted indicated the use of Gronwall's inequality which does not apply here.

Question 2 This is the most popular question among three, and almost every one attempted this question and gained good marks in general. This demonstrated the good understanding of the candidates for the core material covered in this paper. Part (a) exam the basic knowledge about the planer autonomous ODE systems, most candidates are able to demonstrate their skill for locating critical points and sketching the planer diagram showing the essential features of the phase plan. Therefore most candidates received good amount of marks for this part. Part (b) concerns a non-linear but simple planer system. While about half of those attempted failed to argue properly the nature the only critical point, and thus lose some marks. On the other hand most candidates are able to reformulate the system in the polar candidate and therefore are able to sketch the diagram correctly.

Question 3 Many candidates attempted this questions, but received not many good solutions. Part (a) tests the standard material on solution surface and characteristics. The steps in (a) are designed so that the candidate can show his/her understanding of the basic concepts and components about characteristics. Most candidates are able to obtain substantial portion of the marks allocated. While some candidates made some numerical errors, and failed to the domain of definition (for part (v)). Part (b) and (c) cover two different topics each has 5 marks. Everyone can state the Maximum Principle for the Laplacians correctly, but more than half of the candidates who attempted failed do check the condition for the composition of a harmonic function with a convex function – many candidates even could not apply the chain rule correctly! A few candidates attempt to apply the Gronwall's inequality (the version covered in the lectures) to prove the (generalised version of) Gronwall's inequality, which in fact doesn't work for proving (c).

A2: Metric Spaces and Complex Analysis

Question 1 In (a)(i), for $x \in K(K(A))$ candidates usually correctly picked $K(A) \ni k_n \to x$, and $a_{n,m} \in A$ with $a_{n,m} \to k_n$ as $m \to \infty$. Inaccuracies often ensued, e.g. claiming that the diagonal sequence $a_{n,n} \to x$ (this would require a judicious choice of $a_{n,m}$), or writing double limits. Although (a)(ii) is a one-line proof using sequences, the well-meaning emphasis in the Metric Spaces course on using general Topology definitions rather than emphasizing sequences, had the practical outcome that students often wrote a full page of solutions to solve (a)(ii). Part (a)(iii) examples typically involved e^{-x} or arctan or used a patching of $\frac{1}{x}|_{x\geq 1}$ with $1|_{x\leq 1}$; students liked using $A = \{n \in \mathbb{N} : n \geq 1\} \subset \mathbb{R}$ (other options like $A = \mathbb{R}$ often work). For (b), almost all candidates either used the IVT, or showed Y is disconnected. Almost all candidates did (c)(i) successfully. Part (c)(ii) was usually a mess. Candidates often did not clarify what $K(A)$ was, noting only that $(0,0) \in K(A)$ or that $\{0\} \times \mathbb{R} \subset K(A)$, but not emphasizing/proving that $K(A) = A \cup (\{0\} \times \mathbb{R})$: an essential step in the proof (only a handful of candidates elegantly avoided needing this step). Many correct solutions explained that a path from $(-1,0)$ to $(0,0)$ would have unbounded y-coordinate as it approaches the y-axis, which contradicts the continuity of the path.

Question 2 Almost all candidates did (a)(i) correctly. Part (a)(ii) was a mess, despite being bookwork (the course notes consider the general case of bounded functions, and then deduce (a)(ii) from it; a route that a few candidates reproduced). Most candidates successfully argued: f_n Cauchy implies $f_n(x) \in \mathbb{R}$ Cauchy, so $f_n(x)$ converges to some limit, say $f(x)$. Many candidates jumped from this pointwise convergence to assuming uniform convergence, without proving this by going back to the uniform Cauchy assumption. Those candidates that did not forget to prove continuity of f, used the famous "$\varepsilon/3$-proof" from the course notes. A typical but subtle mistake is to run the $\varepsilon/3$-proof before one has shown $\|f - f_n\| \to 0$ uniformly (in the $\varepsilon/3$-proof one is varying x, y so one needs uniform estimates for $|f(x) - f_n(x)|$ and $|f_n(y) - f(y)|$). No marks were taken off if the candidates switched the order of these two steps of the proof. Part (b)(i) was a mess: astonishingly many candidates were unable to write $|\int k(x,y)(f_1(y) - f_2(y))\,dy| \leq \int |k(x,y)| \cdot |f_1(y) - f_2(y)|\,dy$, even though this is presumably a frequently used basic trick in many courses. Absolute values were often misplaced e.g. $\cdots \leq |\int k(x,y)\,dy| \cdot |\sup(f_1 - f_2)|$. Part (b)(ii) went well (rare mistakes were caused by assuming that T rather than K was linear in f). Part (b)(iii) often involved two issues. The first: candidates not proving $K^n(f) \to 0$ as $n \to \infty$ in the formula for $T^n(f)$ obtained by inductively generalising (b)(ii). Some candidates elegantly avoided this issue by choosing $f = g$ or $f = 0$. The second issue involved candidates who did not realise that (b)(ii) was a hint: they instead tried to "plug in" the given solution $\sum K^m g$ to conclude that it works. Although this approach is in principle acceptable, it would require the additional work of showing that the infinite sum converges and K commutes with the infinite sum symbol.

Question 3 Part (a)(i) and (ii) are bookwork and done very well by most students. Very few students forgot to include the Lie derivative L but most were fine. (a)(iii) most student used a method largely different from the solution which is to use polar coordinates to solve the problem elegantly. (iv) was surprising as although most of the problem is a simple substitution a non-neglible number of people have infinities in the results. Others seem to have an additional multiplicative factor in their final result.

(b)(i) was done well by most. (b)(ii) is where the real challenge came and quite a few student wrote a trivial proof that tries to avoid the question entirely. But around 1/ 3 students made the correct observations, utilizing closed disks in their solution. (iii) have similar issues with students trying to avoid the core of the question by not differentiating between $\mathbb{C}$ and $\mathbb{C}\infty$. Those who utilizes the inverse function of f generally continued to find the right solution. (iv) was done quite well by most students as they observe that c must be 0 and the results are given following a rescaling.

Question 4 A common loss of points in 4a) was to forget assumptions in the residual theorem, e.g. that the sum is over a finite set of isolated singularities, that the curve is closed, no singularities on it, etc. In 4b), most candidates succeeded with part 4bi), many attempted to spell out the Laurent series for 4bii), but gave sloppy arguments such as not spelling out the coefficients and just claiming they don't vanish thereby ignoring potential cancellations, and few managed 4biii). A common mistake in 4c) was to choose a contour that did not avoid the singularity at 0, as well as simple calculation mistakes in computing the residues.

Question 5 Almost all candidates managed to get the full points for 5a); however, some lost points for forgetting some assumptions in the theorem and some didn't produce the proof. For 5b), there was generally good progress on parts i) and iii). For ii), most managed to spell out the derivative of h but did not show boundedness. For 5c), very few candidates managed to make substantial progress. Few candiates realised that in ii) the obvious part was that z_n are zeros and that this didn't much explanation, but that the main challenge of the question was to show that there are no other zeros. Similarly for iii), only a handful of candidates attempted to use the logarithmic derivative.

Question 6 Nearly all attempts at 6a) received full points. For 6ai), many candidates ignored that part of the question asked to show the well-definedness of Γ and instead only focused on the holomorphic part of the question. 6bi) was straightforward and didn't give trouble to most candidates. For 6c), most made good progress on i), but many didn't give full arguments for ii), although in general, most attempts did get full or close to full points for 6c).

Question 4 and 5 were the most popular. Few candidates attempted Question 6 but those who did tended to get higher scores.

Long Options

A3: Rings and Modules

Question 1 was on field extensions and algebraic elements. The bookwork in part (a) was well done. In part (b) quite a few candidates failed to fully exploit the irreducibility of the minimum polynomial. Some candidates didn't quite manage to put together the argument using the tower law and finiteness to show that the algebraic numbers formed a field, but there were many good solutions too.

The last part, on the relation between algebraic numbers and algebraic integers, proved difficult, but several candidates did see the right trick to use here.

Question 2 This question, on prime and irreducible elements, proved very popular and was generally well done. Candidates generally showed good understanding of the relation between Euclidean and unique factorisation domains, and the relationship between primes and irreducibles. In the last part, most people managed to show that p was not prime in the Gaussian integers, and quite a few were able to complete the argument to show, using reducibility, that p was a sum of two squares.

Question 3 This question, on modules, proved popular. Candidates mostly seemed comfortable with the idea of finitely generated modules.The part of the question on the Noetherian condition for modules was well done. Many candidates got the right idea for the last part, exhibiting an infinite chain of strictly ascending submodules by considering functions with progressively weaker support conditions. Some got the inclusions the wrong way round and produced a descending chain.

A4: Integration

Question 1

Question 2 This question was attempted by many candidates. Part (a) was broadly well done, though some candidates claimed incorrectly that the functions involved are uniformly bounded, rather than spotting the correct dominating function $\frac{1}{\sqrt{x}}$. Some candidates lost marks for asserting integrability of $\frac{1}{\sqrt{x}}$ on $[0, 1]$ with no comment at all, or by using the fundamental theorem of calculus over all of $[0, 1]$ without handling the

Part (b) proved challenging, though a reasonable number of candidates gave precise arguments to justify that

$$\lim_{n\to\infty} \int_0^n (1 - x/n)^n \log x = \int_0^\infty e^{-x} \log x.$$

Others lost quite a few marks by asserting integrability of $\exp(-x)\log x$ on $[0, \infty)$ with no justification, so as to apply the dominated convergence theorem.

The computation of $\lim_{n\to\infty} \int_0^n (1 - x/n)^n \log x$ proved tricky, with only very few candidates making the substitution $u = 1 - x/n$, and valid arguments were rare. Many candidates tried to use a binominal expansion of $(1 - x/n)^n$, and made some progress, for which there was partial credit, but typically got stuck, or just asserted (often after some computation) that

$$\int_0^n (1 - x/n)^n \log x = \log n - \sum_{r=1}^{n} \frac{1}{r}.$$

In fact, this is not true and the correct calculation is that

$$\int_0^n (1 - x/n)^n \log x = \frac{n}{n+1} \left(\log n - \sum_{r=1}^{n} \frac{1}{r} \right),$$

which was correctly obtained by a small number of candidates.

Question 3

A5: Topology

Question 1 Most candidates attempted this question.

1.ai Some candidates incorrectly gave a definition of limit points that applies only to metric spaces and also used this definition to show that limit points map to limit points.

1aii was done by most candidates. 1aiii was book work that was well done by most candidates, although a few struggled with finding good notation. 1aiv was done by most candidates but some failed to see that there is a unique topology.

1bi. This was generally well done. Some candidates used IFT from prelims while other argued directly showing that the image is an oepn interval, hence homeomorphic to $\mathbb{R}$.

1bii. No candidate gave a complete solution to this. Only one candidate realized the relevance of Baire's theorem, while a few candidates followed the hint and solved the problem assuming $f([a, b])$ contains a ball for some a, b and got partial credit.

1biii) A small number of candidates managed to solve this. A 'proof by picture' was sufficient to get full credit.

Question 2 2ai. Most candidates gave a correct definition but some made mistakes, for example saying that one uses only countable unions of basis sets.

2aii. Many candidates struggled with one of the two directions of this, giving incorrect formulas for the inverse image of an open set.

2aiii. was well done.

2aiv. Around half the candidates did this part, several failed as they did not use that K is closed.

2bi. This was well done but some students did not give the topology and received only partial credit.

2bii was generally well done.

2biii Most candidates did this but often they struggled with the notation and their exposition was longer than necessary.

2biv. A fair number of candidates did this.

2bv. Quite a few candidates that did not do part iv, did realize that it could be applied here and gave complete solutions. Some candidates lost some mark as they did not show that an equivalence class is compact.

Question 3 Fewer students attempted this question, but the ones that attempted it did generally well.

3ai. This was well done by most students. Some found harder to justify Hausdorff.

3aii. This was generally well done apart from compactness. Some students justified compactness showing that combinatorial surfaces are finite simplicial complexes giving an unnecessarily longwinded proof. Some proved also that they are Hausdorff even though this was not part of the question.

3aiii. Was done by practically all who attempted this.

3bi. Very few candidates managed to do this. Some noticed that it was essentially bookwork and applied the argument in the notes and some managed to give a direct argument. Many tried to give an argument applying a single cut and paste operation that clearly did not work.

3bii. Many candidates did this and received complete marks. A common mistake was to claim that the surface given by $aUaV$ is homeomorphic to the one given by $aaUV$.

A6: Differential Equations 2

Question 1 the majority of candidates answered this question, and it was generally done quite well. Quite a few thought that α and β needed to be ± 1 for the problem to be fully self adjoint, whereas it just required $\alpha\beta = 1$. Some candidates failed to make good use of the earlier parts to solve subsequent parts, and went through repeated and lengthy calculations involving integrating by parts to find the adjoint boundary conditions again and again. Quite a number of candidates didn't notice they were asked to find any solutions that exist in (a). The inhomogeneous boundary condition in (c) confused quite a few people.

Question 2 this question was the least popular, but was done quite well by many who attempted it. Quite a lot of candidates didn't seem to read the question very carefully and regurgitated general formulas from the lecture notes (involving the adjoint eigenfunctions w_n and failing to notice that the given eigenfunctions were normalised, for example, as well as using c_n for different constants than how they were defined in the question.) Part (d) unsurprisingly was a bit harder, but quite a few candidates managed to identify the eigenfunctions and eigenvalues.

Question 3 the first part of this question was done quite nicely by many candidates, although the presentation and explanation was in many cases quite all over the place. Common errors were sign errors and algebraic slips, as wells as not being clear about when the coefficient a_1 was forced to be zero or not. Identifying the solutions as $\cosh x/x$ and $\sinh x/x$ was generally straightforward for those who had the correct series (there were some creative attempts at alternative functions from those who had the wrong series coefficients). Part (b) was started well, but the rescaling of y for the inner solution was new, as was the resulting more nuanced matching between the two solutions. The full solution was worked out correctly by a handful of candidates.

A7: Numerical Analysis

Question 1 About 55 candidates attempted question 1. Most correctly answered parts (a)(i) and (a)(ii) concerning the QR factorisation and a slight generalisation of the solution to the least squares problem using an orthogonal-invertible factorisation. In (a)(iii), the most common mistake was justifying why part (a)(ii) may be used. A fair number of candidates decided not to use (a)(ii) for the solution using the SVD factorisation.

Part (b) was more difficult. While (b)(i) was meant to be a 2-3 line proof, many students did not see the simple argument. Most candidates did not do (b)(ii) correctly, with many failing to justify why $U\Sigma^\dagger\Sigma U^\top b = b$, despite the hint. A somewhat common mistake was distributing A through an inner-product: $\langle x, y\rangle = \langle Ax, Ay\rangle$. The hint for (b)(iii) was frequently ignored despite leading to a simple answer.

Question 2 Only 6 candidates did *not* attempt question 2, which appears to be the easiest question on the exam. The number of proofs for (a) lacking all of the details seems high for a problem on a problem sheet. The solutions to the problem sheet should probably be updated to be more clear so that tutors relay the proof more effectively. Nearly every candidate received full marks for (b), which was standard bookwork.

Part (c)(i) received a variety of answers. Some candidates did not read the problem statement carefully enough to see that inner products cost $2n$ operations. Another mistake was assuming $\langle\phi_k, \psi_i\rangle$ takes $\mathcal{O}(k)$ operations – it is not clear from where this misconception came. Some students added their own costs for scalar-vector multiplication and vector-vector addition, which received full marks. While the intention was to simplify the calculations by assuming these computations take $\mathcal{O}(1)$ operations, the problem statement should have included these costs to make the expectations more clear. Some candidates were clever and noticed that certain computations can be re-used, leading to cheaper costs, but this was not required. Part (c)(ii) almost universally received full marks. Some candidates proved orthogonality of the resulting basis, which was not expected/necessary.

Answers to part (d) depended heavily on the exact cost calculation performed in (c). The main mistake here was not considering the cost of computing the matrix M when the basis is not orthogonal. Too many students did not know the proper definition of a positive definite matrix, where the statement $M^\top M > 0$ appears a number of times. Everyone defined M so that M is positive definite; this normalisation could have been incorporated into part (b). Less than half of the candidates successfully proved that M is positive definite.

Question 3 33 candidates attempted question 3, the ODE question. This seems to be a substantial increase compared to previous years, possibly owing to writing the questions to encourage more attempts. For (a), many candidates were not very careful when defining Gauss-Legendre quadrature, forgetting the polynomial degree or not stating that the polynomials are orthogonal. Many also missed the change of variable to integrate over a general bounded interval. Moreover, many did not correctly state the quadrature error result from lecture, while others proved the error bound directly. In (b), many candidates did not notice to use (a) to prove (7). This often led to incorrect lengthy Taylor expansions.

For (c), most candidates provided a reasonable explanation for deriving the scheme. Deriving some Runge-Kutta methods was moved from nonexaminable to examinable material this term, so this appears to have been successful. At least half did not write the correct Butcher table for the scheme, and many did not use the consistency error order conditions from the lecture to easily verify the consistency order. Most correctly computed the stability function for (9) and (10) and were able to show that (9) is not A-stable. A large number of candidates ignored the hint, complicating the proof of A-stability for (10), while nearly every candidate that computed the stability function verified L-stability correctly.

A8: Probability

See Mathematics and Statistics report.

A9: Statistics

See Mathematics and Statistics report.

A10: Fluids and Waves

Question 1 This question was quite popular, though candidates struggled with part (b) in particular. Part (a) was generally well done, though several candidates failed to spot that the differential equation for $f(r)$ was of Euler form and hence were not able to solve for f. In part (b), candidates generally followed the expected path of writing the difference $T(\mathbf{u}') - T(\nabla\phi)$ as the integral of $|\nabla\phi + \tilde{\mathbf{u}}|^2 - |\nabla\phi|^2$; at this point, however, a surprising number of candidates attempted to make use of a (non-existent) version of the triangle inequality to make progress, rather than noting that $|\nabla\phi + \tilde{\mathbf{u}}|^2 - |\nabla\phi|^2 = |\tilde{\mathbf{u}}|^2 + 2\tilde{\mathbf{u}} \cdot \nabla\phi$ and then using the Divergence Theorem to show that the second term of the difference ultimately does not contribute to the difference integral.

Question 2 This question was extremely popular, being attempted by almost all candidates. This question was also very well done on the whole. Common errors included: not rearranging the potential from the modified Circle Theorem into the form given in (*), forgetting to differentiate $w(z)$ when applying Blasius' Theorem and not noticing that the only singularity enclosed by the integration contour is the location of the doublet, $z = b$, rather than the image doublet at $z = a^2/b$.

Question 3 This question was generally well done. A common error was to give a condition on L in part (b)(iii) that was dependent on the mode number n — instability may occur whenever there exists an unstable mode and so the condition for L required in this part must be independent of n.

A11: Quantum Theory

About 3/4 of the candidates chose Questions 1 and 2, and about 1/4 chose Questions 2 and 3. (In addition two candidates chose Questions 1 and 3 and one submitted all three.) As in the previous two years, the first strategy is seemingly preferred by students who are uncomfortable with angular momentum. The second strategy earned more marks on average, possibly due to requiring less computations, but better conceptual understanding. The average marks on all three questions were similar.

Question 1

The bookwork parts of both part a) and b) were done well. In a)(iii) candidates often set $t = 0$, which left too little information to prove $\mathcal{I} = 0$. Only very few candidates made a serious attempt at b)(iii) and none came close to a solution. A common mistake was not realising that X simply acts as multiplication by x. Candidates often set $t = 0$ and dropped cross terms between ϕ and χ, both without justification. In fact cross terms can be shown to vanish by performing the y integral $\int_0^b dy\, \overline{\psi_1(y)}\psi_2(y) = 0$. A good solution strategy is performing the y integral first by using the orthonormality property of the one-dimensional stationary states.

Question 2

Part a) was generally done well with some candidates struggling to complete the induction proof. In part b)(i) there was a very good level of commutator manipulations from candidates, although many made sign and factor mistakes. A good solution strategy is decomposing the complicated computations into simpler building blocks. In part b)(ii) candidates made many mistakes in converting G, H, K into differential operators, and subsequently the computation of $[K, H]$ acting on a wave function $\psi(\xi)$ often became chaotic.

Question 3

The bookwork part of part a) was done perfectly, and all candidates had a reasonable strategy to solve a)(iii), although sometimes they did too much computation instead of appealing to the facts that $J_{\mathbf{n}}$ is just a component of angular momentum with known spectrum and that its eigenstates are orthonormal. In part b) candidates made a variety of small mistakes, but the general picture seems to have been clear. The candidates who got to the Quantum Key Distribution part gave excellent answers.

Short Options

ASO: Q1. Number Theory

Most students did well on the question. Part (a) was Bookwork and most students answered it well. Part (b) was Similar. (b)(i) and (b)(ii) were fine for most students. Not all students saw how to combine (b)(i) and (b)(ii) in order to answer (b)(iii) but there were a few good answers. Part (c) was Similar/ New. (c)(i) was answered well by most students. The first part of (c)(ii) was also answered well by most students but many did not see how to do the second part. (c)(iii) was challenging and not many students answered it.

ASO: Q2. Group Theory

The average mark was 16.6 and the median 17. The highest mark was 22/25.

I asked ChatGPT to sit the exam giving it ample time (20 minutes). It produced a script in 58 seconds, which I marked applying the mark scheme. It received 21/25, which is the second highest score.

Almost everyone received full marks on Questions a), b) and the first two parts of c). These were a combination of book work and material close to example sheets.

Question ciii) was also taken verbatim from an exercise in the second example sheet and was done well by a large majority of students.

Question civ) however was done well by only 3 students (and by ChatGPT). Nonetheless, most students only lost one mark here, because the mark scheme was generous in allowing 1 mark for the simple check that the normalizer is a subgroup.

Question d) was devoted to applying the Sylow theorems on a concrete example. It was harder than the previous two parts of the question.

Question di) required to factorize 2025 appropriately and apply a basic propery of factorization of groups seen in class. It split students quite evenly with just a bit more than half of them answering correctly.

Question dii) had three subparts with one mark each. Only one student managed to get the full three marks on this question (and scored 22/25 overall, the highest mark) by appropriately justifying the maximality of P_3. A majority of students received 2 marks.

Question diii) was awarded 2 marks and split students quite evenly.

None of the students, nor the AI, was able to make any convincing argument for div), which required more thought than the other questions.

Question dv) was a basic reality check and the vast majority of students got it correctly.

The exam's markscheme attributed a lot of marks to bookwork and exercises from seen example sheets (roughly 10 marks). The fact that the average was well above is a sign of a strong cohort. In retrospect, the harder parts of the exam were probably too hard. However this was balanced by a generous markscheme.

ASO: Q3. Projective Geometry

The question was well answered with candidates achieving an average mark of over 20. This seemed to be much more a reflection of the quality of the scripts rather than the question being too easy. Possibly the hint for the last part took the sting out of the new material and should have been omitted, but that's a rather marginal comment and it was abundantly clear that the majority of students had understood the course well, even thoroughly.

In part (a) the expected answer for the dual notion of 'concurrent' was 'coplanar'. For example, three concurrent lines dualize to three coplanar lines. This was a stumbling block in quite a few scripts and even if the right answer was given little or no justification was sometimes given even though explicitly sought in the question.

ASO: Q5. Integral Transforms

Question 4(a) asked to solve a boundary value problem using the Laplace transform. Most candidates transformed the equation correctly and obtained the correct integrating factor for the resulting first order ODE. Some failed due to algebraic errors or by including the initial values for f incorrectly. Obtaining the general solution required integration by parts which only some candidates got correctly. Some forgot to include the integration constant, only few gave a correct argument for its value. Inverting to get the correct answer was only accomplished by the best candidates.
Question 4(b) was easier than the second half of 4(b) and generally done very well. Overall, many candidates got very good or even complete answers for all sub parts. Some candidates failed to quote the correct definition, or got the wrong answers for the examples or gave deficient, sometimes even outrightly wrong reasons for their answer.

ASO: Q6. Calculus of Variations

The question seemed relatively unpopular. Quite a few candidates produced perfect or near-perfect solutions, but I was disappointed that a lot of candidates stopped after collecting their first four very easy marks in part (a). The main difficulties in (b) were in calculating (vector) $\dot{r}$, and trying to obtain H from L using lack of explicit theta dependence instead of lack of explicit time dependence. The main difficulties in parts (c) and (d) were finding the value of H and H from boundary conditions. Several solutions carries a generic H until the end, then tried to relate H to r_0 to match the solution as given.

The given expression for (d) had a silly mistake (from doing maths in my head while I couldn't write with a hand injury). The 1/r should be inside the integral, which should also be over a dummy variable r . One candidate wrote that they were confused, so I marked their part (d) generously. Two other candidates commented about the strange expression, and the rest either didn't notice or accepted what I meant rather than what I wrote.

ASO: Q7. Graph Theory

Overall this question was perhaps a little on the straightforward side, especially part (a), although it could (and perhaps should) have been marked significantly more harshly. Indeed, many descriptions of Kruskal's algorithm were not mathematically correct, though the reader could tell what the candidate meant, and that was correct.

In part (a) some candidates were not clear whether they were talking about a graph or a set of edges. For those who were clear, some elected to add vertices as the algorithm proceeds, whereas it is cleaner to follow the notes and start with the entire vertex set of G. (Otherwise you end up writing almost the same argument twice, to prove that the constructed subgraph is connected, and that it is spanning.) There are many ways to describe the algorithm; a number of candidates wrote out one that considers each edge once. This is good for efficient implementation, but slightly less simple for the description and analysis.

(b)(i) was mostly well done, though you do have to mention the graph being connected at some point. For (b)(ii) it's simplest (and answers (i) also) to show that at each step, vertices have the same label if and only if they are in the same component of the graph formed by the edges chosen so far.

(c)(i) is a variant of the proof that Kruskal works, and turned out to be slightly tricky. Perhaps the shortest argument is 'dual' to that for Kruskal: consider the first edge e deleted from T_0. This separates T_0 into two components, so there is some not yet deleted edge f joining them; now compare the costs of e and f.

(c)(ii) and (iii) were generally well done. For (c)(ii) you can observe that Kruskal needs at most $n-1$ rounds whereas algorithm **B** can take up to order n^2 rounds. Also (which no-one commented on), Algorithm **A** gives a (partial) description of a quick way to actually check whether each edge would form a cycle when implementing Kruskal. There is no obvious analogue for **B**.

ASO: Q9. Modelling in Mathematical Biology

Most candidates were able to make a reasonable attempt at the standard bookwork sections of this question. A number of candidates did not appear to know the standard method for linear stability analysis of a steady state for a discrete model (part (a)). Almost all candidates were able to linearise the model but many then did not know how to solve the resultant linear discrete equation.

Most candidates made good attempts at cobwebbing (part (b)(iii)) but very few labelled the cobwebs with arrows and fewer still commented that the solution decreased monotonically.

For the problem concerning the tangent bifurcation (part (c)(i)), most candidates did the hard part of calculating the derivature of f at the steady state, finding it to be $1 - \frac{N^*ba}{(1+aN^*)}$, where N^* is the positive steady state. The majority of candidates then failed to notice that this quantity was trivially strictly less than 1 and so a tangent bifurcation cannot occur.

For part (c)(ii), to obtain the stated inequality required division by $(b-2)$ without reversal of the inequality. This is justified because of the given condition $b > 2$ but most candidates did not state this.

For part (c)(iii) many candidates just assumed that the non-zero steady state was linearly stable but did not prove it.

Part (d) was new and challenging and attempted by only a few candidates. Some candidates misunderstood the phrase "given by $f(N^{max})$ and $f^2(N^{max})$, where N^{max} is the maximum of f" to mean that the maximum value of f was N^{max}.

E. Comments on performance of identifiable individuals

1. Prizes

The Gibbs Prizes for Mathematics Part A were awarded to: Jiongjie Hua, St. Catherine's College
Dylan Knight, St. John's College

2. Mitigating Circumstances Notices to Examiners

A total of 16 notices were received and each carefully considered. In 5 cases the examiners chose to disregard a paper. The remaining 11 notices and decisions are to be passed to the Part B exam board for consideration at the point of classification.

F. Names of members of the Board of Examiners

- **Examiners:**
  Prof. Zhongmin Qian (Chair)
  Prof. James Newton
  Prof. Alex Ritter
  Prof. Harald Oberhauser
  Dr. Neil Laws
  Prof. James Martin
  Prof. Mark Blyth (External Examiner)
  Prof. Ali Taheri (External Examiner)
  Prof. Owen Jones (External Examiner)

- **Assessors:**
  Prof Emmanuel Breuillard
  Prof Paul Dellar
  Prof Andrew Dancer
  Prof Ian Hewitt
  Prof Kobi Kremnitzer
  Dr Charles Parker
  Prof Philip Maini
  Dr Richard Earl
  Prof Mark Mezei
  Prof Andreas Muench
  Prof Panagiotis Papazoglou
  Prof Oliver Riordan
  Prof Stuart White
  Prof Dominic Vella