Evaluation Criteria for Documents and Rating of Individual Achievements: for International Applicants to the Educational Master Programme "Advanced Mathematics"

Admissions test form. This admissions test consists of two stages:
1. Competitive selection of documents
(portfolios)
2. An interview
The second stage is only for those applicants who have obtained at least 35 points for the first stage.

Stage 1: The competitive selection of documents (portfolios)

The official documents, certificates and other materials must be submitted in legible copies. If any document is written in a language other than Russian or English, the applicant must submit its translation into one of these languages (translations into Russian have to be notarised by either a notary or the Russian embassy/consulate in the foreign country or the embassy/consulate of the foreign country in Russia unless otherwise specified in the international agreements of the Russian Federation).

Section. 1.1. Portfolio composition: the list of documents and points scored

Documents / documented facts for evaluation		Assessment criteria	The number of points scored
1	Motivation letter (obligatory)	The criteria are specified below, in Section 1.2 "Motivation letter"	20
2	Essay (a research paper) (obligatory)	The criteria are specified in Section 1.3 "Essay"	10
3	Curriculum Vitae (CV) containing the complete and continuous history of the applicant's professional activity and education prior to documents submission. (obligatory)	The experts evaluate whether the education comply with the world standards (taking into account the reputation of the educational institutions in terms of the mathematical sciences, the reputation of the programmes in terms of the presence and number of graduates who have obtained world-wide results, additional education obtained during summer schools, inter-university exchange programmes and similar events). Diplomas of winners and laureates of international and national student olympiads in the subjects corresponding to the main field of	35

		study in accordance with the relevant consolidated group of fields of study, and information on the applicant's publications in the relevant subjects.	
4	Letters of recommendation (at least 1, no more than 2). Each letter must be printed on an official blank of the university. It also must contain the recommender's contact information and his/her signature.	The criteria are specified in Section 1.4 "Letters of recommendation"	25
5	A copy of the document confirming the level of education (obligatory). (A copy of the diploma and the diploma supplement, with the list of academic disciplines studied and grades awarded. In case the diploma is absent at the moment of the documents submission, the applicant must submit a transcript of records with the grades confirming the applicant's most recent assessment.) A bachelor's / master's diploma issued in the fields of study and specialities in accordance with the relevant consolidated group of fields of study and specialities.	Master's diploma	5
		Bachelor's diploma	0
		Maximum score for the section	**5**
7	Documents confirming the applicant's English language proficiency (international certificates and other documents). If English is the applicant's native language or the language of instruction of the previous educational programme, the applicant obtains 5 points automatically.	English: TOEFL, IELTS, Cambridge CAE, Cambridge CPE, Cambridge FCE – A	5

	Maximum score for the section	5
Only one document is considered. If two or more documents are submitted, the points shall not be summarised.		
	TOTAL SCORE	**100**

Section 1.2. Motivation letter
up to 20 points

In case any unjustified borrowings are found, the applicant obtains 0 points for his/her motivation letter

Requirements to the motivation letter formatting and content

1. Font: Times New Roman, point size: 12, line interval: 1,5.

2. The motivation letter must be written in English. It must contain the following:
− information on the applicant's professional training and/or any other activity that may be useful during the period of study in the chosen master's degree programme; information on the success and achievements in the chosen field;

− a well-reasoned substantiation of why the applicant has chosen this particular master's degree programme at St Petersburg University. The applicant must also prove his/her interest in the chosen programme;

− prospects / plans of the obtained knowledge implementation in future professional career.

Evaluation criteria	Score
Well-reasoned substantiation of why the applicant has chosen this programme	1
Well-reasoned substantiation of why the applicant has chosen St Petersburg University	1
The presence of description of the competences the applicant is willing to acquire during his/her studies	1
Description of the applicant's academic and practical achievements	From 0 to 10

other information and characteristics the applicant considers relevant (practical experience, basic education, individual abilities and hobbies)	1
Description of the prospects of the obtained knowledge implementation in future professional career.	1
English language skills	From 0 to 5
Maximum score	**20**

Section 1.3. Essay (research paper)
up to 10 points

The applicant personally formulates the title of his/her essay (research paper) within the framework of the field of study of the chosen programme. It is permitted to submit essays based on the applicant's theses (bachelor's, master's, etc.) or scientific publications.

In case any unjustified borrowings are found, the applicant obtains 0 points for his/her essay (research paper).

Requirements to the essay (research paper) formatting and content

1. The essay must be composed in either Russian or English.

2. The total length must not exceed 60,000 printed characters (with spaces), including the bibliography.

3. Font: Times New Roman, point size: 12, line interval: 1,5.

4. All the sources must be properly cited.

5. The essay text must be complete and thoroughly structured. It must contain an introduction (where the issue is formulated), the main part (with well-reasoned substantial points), a conclusion (with the author's own conclusions concerning the issue) and a bibliography (not exceeding 2 pages).

6. The author must demonstrate a good knowledge of the subject of research, terminology, awareness of the common scientific concepts in the given subject area, understanding of the new trends and problems arising in this subject studies.

Evaluation criteria	Points
Correspondence of the essay (research paper) topic to the main field of study, correspondence of the text to the formulated topic and applicability of the prospective research	From 0 to 1
Problem statement in accordance with the chosen topic	From 0 to 1
Awareness of the existing scientific concepts related to the chosen range of issues	From 0 to 2

Presence of the individual approach to the problem stated; descriptions of the author's theoretical and pract	From 0 to 5
The structured character of the paper, correct usage of scientific terminology, absence of factual, stylistic and other errors	From 0 to 1

Section 1.4. Letters of recommendation
up to 25 points

The letters of recommendation must be sent by the recommender to admission@spbu.ru, with a copy to n.ratkovskaia@spbu.ru.

The experts evaluate:
- the level of the recommender's scientific results (including those obtained during the 10 previous years)
- the familiarity level between the recommender and the recommendee,
The recommender's evaluation of the recommendee's achievements and opportunities is also taken into account.

Stage 2. Interview

The second stage involves an interview with the applicant. The applicant is offered questions, the answers to which demonstrate his/her culture of mathematical reasoning, the level of his/her training and his/her command of mathematics, his/her logical reasoning ability and the ability to understand new concepts and operate them. The applicant may choose four or more topics out of those listed in Section 2.1. He/she may be asked questions on these topics.
The test is held via videoconferencing in English.

The answer to each question is evaluated by awarding the applicant a particular number of points. The maximum score for the interview is 100 points.
A list of applicants recommended for enrollment and a waiting list are formed based on the number of points awarded to the applicants for the interview.

Section 2.1. Main topics to check the level of training in mathematics.

Topic 1: Algebra
Rings, subrings, ideals. Homomorphism theorem. Polynomial ring, Bezout theorem. Factoriality of the polynomial ring over the field. Vector

spaces. Linear dependence. The existence of a basis in a vector space. Linear mapping. Rank of a linear map, Kronecker–Capelli theorem. Eigenvalues and the characteristic polynomial. Hamilton–Cayley Theorem. Nilpotent operators. Jordan normal form over complex numbers.

Topic 2: Geometry and topology

Euclidean spaces, scalar product, distances, angles. Affine and orthogonal transformations, rigid displacements. Curves and surfaces of the second order. Curvature of the planar curve, curvature and torsion of a spatial curve, Frenet formula. Metric and topological spaces, continuous maps of topological spaces. Connectedness and path connectedness, compactness. Homotopy of maps. The fundamental group of a topological space. The fundamental group of a circle.

Topic 3: Mathematical analysis and Fourier analysis

Limits. Compactness. Continuity. Uniform convergence. Differential and derivative. Extrema of functions. Taylor series. Riemann Integral. Differentiable mappings. Conditional extrema. Lagrange multipliers method. The Lebesgue Integral. L^p classes. Tonelli's theorem. Fubini's Theorem. Convolution of functions. Holomorphic function. Cauchy's Theorem. Liouville theorem. Residues. Rouché's Theorem. Fourier series. The Dirichlet and Fejer kernels. Decay of Fourier coefficients. Plancherel's Theorem.

Topic 4: Ordinary differential equations and mathematical physics

Existence and uniqueness of solutions. Linear systems of differential equations. Dependence of solutions on initial data and parameters. Lyapunov stability. Basic problems of mathematical physics. Distributional solution of differential equations. The fundamental solution and Cauchy problem.

Topic 5: Discrete mathematics

Graphs, directed graphs, trees, connected components in the directed and undirected graph. Matching, the Hall Lemma. Planar graphs, Euler formula. Eulerian paths and cycles. Permutations, cyclic type. Combinations with and without repetitions. Partial permutations.

Topic 6: Probability theory

Probability spaces. Distributions of random variables. Criteria for independence of random variables. Numerical characteristics of random variables. Bernoulli tests. Law of Large Numbers. Local and integral limit theorems of de Moivre–Laplace. Central limit theorem for sums of independent random variables. Characteristic functions. Markov chains with finite or countable set of states. Discrete-time martingales.

Topic 7: Mathematical logic and set theory

The language of propositional classical logic and its two-valued semantics. Disjunctive normal forms (DNF's) and conjunctive normal forms

(CNF's). The DNF and CNF theorems (on reduction of propositional formulas to DNF's and CNF's respectively). A Hilbert-style calculus for propositional classical logic and derivability in it. The deduction theorem for this calculus. Consistent and maximal consistent sets. The strong completeness theorem (including soundness) for the Hilbert-style calculus for propositional classical logic and its most important consequences.

Paradoxes of naive set theory. Zermelo–Fraenkel axioms and the Axiom of Choice. Basic operations on sets and their basic properties. Ordered pairs, triples, etc. Cartesian products. Relations and functions. Equivalence relations and partial orders. Transfinite induction. Well ordered sets and transfinite recursion. Isomorphism of well ordered sets. Comparability of well ordered sets. Equinumerosity and its elementary properties. Cantor–Schröder–Bernstein theorem. The theorem on the comparability of cardinalities. Cantor theorem (on the cardinality of the set of all subsets of a given set). Countable sets and their basic properties. Cardinalities of unions and products of sets.

Topic 8: Theoretical Computer Science

Time complexity of algorithms and estimation methods. Master theorem. Algorithms for searching in graphs (depth-first search, breadth-first search, Dijkstra's algorithm). Sorting algorithms (insertion sort, merge sort, quicksort, heapsort). Data structures for sets (linked list, AVL tree or red-black tree, hash table), and operations with them. Finite automata (deterministic and non-deterministic), their equivalence. Computational complexity: complexity class NP, examples of NP-complete problems. Algorithmically intractable problems.

SECTION 2.1.1 BIBLIOGRAPHY

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3. M.P. do Carmo. Differential Geometry of Curves and Surfaces. Prentice-Hall, 1976. [Chapter 1.]
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8. G. Teschl. Ordinary Differential Equations and Dynamical Systems. AMS, 2012. [Chapters 2, 3, 6.]
9. G.B. Folland. Introduction to Partial Differential Equations. Princeton University Press, 1995. [Chapters 1–4.]
10. J.H. van Lint and R.M. Wilson. A Course in Combinatorics. Cambridge University Press, 1992 (reprinted in 1994 and 1996). [Chapters 1, 2, 10, 13, 14, 15.]
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12. A.N. Shiryaev. Probability. 2nd ed. Springer, 1996. [Chapters 1–2.]
13. J.D. Monk. Mathematical Logic. Springer-Verlag, 1976. [Chapter 8.]

14. K. Kuratowski and A. Mostowski. Set Theory. North-Holland Publishing Company, 1968. [Sections I.1–I.6, II.1–II.3.]
15. N.K. Vereshchagin and A. Shen. Basic Set Theory. AMS, 2002. [Sections 1.1, 1.2, 2.1, 2.2.]
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17. J. Hopcroft, R. Motwani, J. Ullman "Introduction to Automata Theory, Languages, and Computation, 3rd Edition" (Pearson) 2013.

Deadline for acceptance and notification of documents to the master programme "Advanced Mathematics"

From February 11 to 11:59 p.m., Moscow standard time, May 29, 2020 — acceptance and notification of competition documents (portfolios)

Within 3 weeks after the complete set of documents has been submitted and their completeness has been confirmed by the International Admission office, the applicant shall be informed on the mark awarded for his/her portfolio. If 35 or more points have been awarded, a personal interview shall be appointed.

Within one month from the interview, the applicant shall be informed on the mark awarded for the second stage of the admissions tests (the interview) and whether he/she has been recommended for enrollment (or included into the waiting list).

June 22, 2020 – announcement of the final results concerning recommendation for enrollment of those included into the waiting list.