Санкт-Петербургский филиал федерального государственного автономного образовательного учреждения высшего образования "Национальный исследовательский университет "Высшая школа экономики"

Факультет Санкт-Петербургская школа
физико-математических и компьютерных наук
Национального исследовательского университета
«Высшая школа экономики»

Департамент прикладной математики и бизнес-информатики

Рабочая программа дисциплины
Алгебра и анализ (преподается на английском языке)

для образовательной программы «Социология и социальная информатика»
направления подготовки 39.03.01 «Социология»
уровень бакалавриат

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Утверждена Академическим советом образовательной программы

«30» августа 2018 г., № протокола ___1____

Академический руководитель образовательной программы

Д.А. Александров _____

Санкт-Петербург, 2018

Course Syllabus

Title of the course	**Algebra and Analysis (offered in English)**		
Title of the Academic Programme	Sociology and Social Informatics		
Type of the course	Core		
Prerequisites	High school Algebra and Geometry		
ECTS workload	6		
Total indicative study hours	Directed Study	Self-directed study	Total
	60	168	228
Course Overview	The course of Algebra and Analysis (modules 1, 2) is intended for beginners. Its goal is to introduce the students to the language of mathematics and basic ideas of vectors, matrices, derivation, and integration. These are indispensable tools of any domain of science using data analyses. Special attention will be devoted to applications. This course will help you to gain a higher level of mathematical maturity necessary in subsequent courses.		
Intended Learning Outcomes (ILO)	When you have successfully completed this course you are expected to – Multiply matrices, solve systems of linear equations – Understand the language of the set theory, foundations of analyses – Understand geometric meaning of linear algebra, integration, differentiation, Fourier series – Solve simple problems in these areas Know examples of differential equations and how to solve them		
Teaching and Learning Methods	Lectures, practical lessons, homework reading and solving problems.		

Content and Structure of the Course

№	Topic / Course Chapter	Total	Directed Study		Self-directed Study
			Lectures	Tutorials	
1	Properties of elementary functions	22	4	4	14
2	Limits of functions	34	6	4	24
3	Differential calculus and its applications	40	4	6	30
4	Matrices and determinants	28	4	4	20
5	Systems of linear equations	28	4	4	20
6	Vector algebra	38	4	4	30

7	Analytic geometry	38	4	4	30
Total study hours		228	30	30	168

Indicative Assessment Methods and Strategy	**Homework** There is a list of problems for each practical lesson. You are expected to solve at least some of them at home. Also, you will be provided with additional individual homework. **Tests and Exam:** The final examination (80 min) will comprise eight of the problems in the total list of homework. There will be also three tests: 15min (matrix multiplication, a system of linear equations, a problem in set theory), 15min (differentiation, integration, analyses of a graph of a function), 40 min (two theoretical questions with proofs). To fulfill the requirement for class participation you must present at least one compete solution of a problem at the blackboard during the first two modules. Each problem can be presented by at most one student. **Grading Policy:** **Intermediate note:** Class participation 10%, individual homework 10%, three tests (27%, 27%, 26%). **Final note:** intermediate note - 60% + final exam - 40%.
Readings / Indicative Learning Resources	Mandatory 1. Treiman, J. Calculus with Vectors [Electronic Resource] / Jay S. Treiman. - Springer International Publishing, 2014. - 406 p. - Authorized access: https://link.springer.com/book/10.1007%2F978-3-319-09438-0 - (Online Digital Library "Springer Ebooks"). 2. Robbiano, L. Linear Algebra for Everyone [Electronic Resource] / Lorenzo Robbiano. - Springer Milan, 2011. - 224 p. - Authorized access: https://proxylibrary.hse.ru:2176/book/10.1007/978-88-470-1839-6 - (Online Digital Library "Springer Ebooks"). Optional 1. Aleskerov, F. Linear Algebra for Economists [Electronic Resource] / Fuad Aleskerov, Hasan Ersel, Dmitri Piontkovski. - Springer Berlin Heidelberg, 2011. - 283 p. - Authorized access: https://proxylibrary.hse.ru:2066/10.1007/978-3-642-20570-5 -(Online Digital Library "Springer Ebooks"). 2. Shafarevich, I. Linear Algebra and Geometry [Electronic Resource] / Igor R. Shafarevich, Alexey O. Remizov. - Springer Berlin Heidelberg, 2013. - 536 p. - Authorized access: https://link.springer.com/book/10.1007%2F978-3-642-30994-6 - (Online Digital Library "Springer Ebooks").

Indicative Self- Study	**Type**	**+/–**	**Hours**

Strategies	Reading for seminars / tutorials (lecture materials, mandatory and optional resources)	+	65
	Assignments for seminars / tutorials / labs	+	65
	E-learning / distance learning (MOOC / LMS)	-	
	Fieldwork	-	
	Project work	-	
	Other (please specify)	-	
	Preparation for the exam	+	38
Academic Support for the Course	Academic support for the course is provided via LMS, where students can find: guidelines and recommendations for doing the course; guidelines and recommendations for self-study; samples of assessment materials		
Facilities, Equipment and Software	none		
Course Instructor	Nikita Kalinin		

Annex 1

Course Content

Module 1	
Topic 1. Elements of Linear algebra.	
1	Matrixes. Actions with matrices. Square matrix. Determinant.
2	The inverse matrix. The rank of a matrix.
3	Gaussian elimination method. Kramer's Theorem. Kronecker-Capelli Theorem.
Topic 2. Elements of vector algebra and analytic geometry.	
4	Vector space. Geometric interpretation of the vector. Linear operations on vectors and their properties. Collinear vectors. Coplanar vectors. Single orts. Scalar product of vectors and its properties. Length (norm) of the vector.
5	The angle between the vectors. A linear combination of the vector system. Linear dependence and independence of vectors. Basis. Decomposition of the vector on the basis. Vector product and its properties. Mixed product of vectors.
6	The equation of a line. Types of equations of a straight line the Distance from a point to a straight line. The angle between the lines, the condition of parallelism and perpendicularity. The equation of the circle. Plane in space, types of the equation of the plane. A straight line in space, Canonical and parametric equations of a straight line. Relative position of straight line and plane.
TEST 1	
Module 2	
Topic 3. Limits and continuity.	
1	Sequence, divergent sequence, limits of the sequence. Functions. Limits of the function. Properties of the function limits. Indeterminate forms.
2	Fundamental limits. Equivalent functions. Continuity of the function. Discontinuity points and their classification
Individual homework	
Topic 4. Basics of Differential Calculus. Applications	
3	The definition of the derivative, its physical and geometrical sense. The relationship of continuity and differentiability. Derivative of sum, product and particular. Table of derivatives of basic elementary functions.
4	Differential. Higher order derivatives and differentials. Some theorems on differentiable functions. L'hopital's Rule.
5	Increasing and decreasing function. Extremum. Convexity, concavity, inflection points, asymptotes.
6	Study of the function and its plotting.
TEST 2	
Topic 5. Basics of Integral Calculus	
7	An antiderivative and indefinite integral. Properties of the indefinite integral. Table of integrals.
8	Basic methods of integration. The definition of a certain integral and its geometric meaning. Properties of a certain integral. Newton-Leibniz Formula
TEST 3	

Sample Written Exam

Variant 1

1. Define the scalar product of two vectors in R^3 and the length of a vector.
2. Give an example of two 2×2 matrices that do not commute.
3. Prove by definition of the limit of a sequence that $\lim_{n\to\infty} \frac{n+1}{n+2} = 1$
4. State and prove Lagrange's theorem
5. Solve the linear system $\begin{cases} 2x + y = 3 \\ x + 3y = 2 \end{cases}$ by using Cramer's formulas
6. Find the limit of the following sequence:

$$\lim_{n\to\infty} \frac{n^3 + 1}{(3n + 1)(n^2 + 2n + 1)}$$

7. Find the following limit by using the relevant equivalent functions:

$$\lim_{x\to 0} \frac{\sin(x^2)}{(e^{2x} - 1)\ln(1 + 3x)}$$

8. Compute the following indefinite integrals:

$$\int (x + 1)\sin x dx, \int \frac{\cos x}{\sin x} dx$$

Annex 2

Assessment Methods and Criteria

Assessment Methods

Types of Assessment	Forms of Assessment	Modules			
		1	2	3	4
Formative Assessment	Test	*	* *		
	Essay				
	Report/Presentation				
	Project				
	In-class Participation	*	*		
	Quiz				
	Individual Homework		*		
Interim Assessment (if required)	Assignment (e.g. written assignment)				
Summative Assessment	Exam		*		

Assessment Criteria

In-class Participation

Grades	Assessment Criteria
«Excellent» (8-10)	A critical analysis which demonstrates original thinking and shows strong evidence of preparatory research and broad background knowledge.
«Good» (6-7)	Shows strong evidence of preparatory research and broad background knowledge. Excellent oral expression.
«Satisfactory» (4-5)	Satisfactory overall, showing a fair knowledge of the topic, a reasonable standard of expression. Some hesitation in answering follow-up questions and/or gives incomplete or partly irrelevant answers.
«Fail» (0-2)	Limited evidence of relevant knowledge and an attempt to address the topic. Unable to offer relevant information or opinion in answer to follow-up questions.

Written Assignments (Individual Homework, Test/Quiz, Written Exam, etc.)

Grades	Assessment Criteria
«Excellent» (8-10)	Has a clear argument, which addresses the topic and responds effectively to all aspects of the task. Fully satisfies all the requirements

	of the task; rare minor errors occur;
«Good» (6-7)	Responds to most aspects of the topic with a clear, explicit argument. Covers the requirements of the task; may produce occasional errors.
«Satisfactory» (4-5)	Generally addresses the task; the format may be inappropriate in places; display little evidence of (depending on the assignment): independent thought and critical judgement include a partial superficial coverage of the key issues, lack critical analysis, may make frequent errors.
«Fail» (0-2)	Fails to demonstrate any appropriate knowledge.

Recommendations for students about organization of self-study

Self-study is organized in order to:

- Systemize theoretical knowledge received at lectures;
- Extending theoretical knowledge;
- Learn how to use legal, regulatory, referential information and professional literature;
- Development of cognitive and soft skills: creativity and self-sufficiency;
- Enhancing critical thinking and personal development skills;
- Development of research skills;
- Obtaining skills of efficient independent professional activities.

Self-study, which is not included into a course syllabus, but aimed at extending knowledge about the subject, is up to the student's own initiative. A teacher recommends relevant resources for self-study, defines relevant methods for self-study and demonstrates students' past experiences. Tasks for self-study and its content can vary depending on individual characteristics of a student. Self-study can be arranged individually or in groups both offline and online depending on the objectives, topics and difficulty degree. Assessment of self-study is made in the framework of teaching load for seminars or tests.

Special conditions for organization of learning process for students with special needs

The following types of comprehension of learning information (including e-learning and distance learning) can be offered to students with disabilities (by their written request) in accordance with their individual psychophysical characteristics:

1) *for persons with vision disorders:* a printed text in enlarged font; an electronic document; audios (transferring of learning materials into the audio); an individual advising with an assistance of a sign language interpreter; individual assignments and advising.
2) *for persons with hearing disorders: a* printed text; an electronic document; video materials with subtitles; an individual advising with an assistance of a sign language interpreter; individual assignments and advising.
3) *for persons with muscle-skeleton disorders: a* printed text; an electronic document; audios; individual assignments and advising.

Annex 3

Аннотация на русском языке

Алгебра и анализ

Целями освоения дисциплины «Алгебра и анализ» являются изучение разделов линейной алгебры и математического анализа, позволяющее студенту ориентироваться в прикладных вопросах, требующих использования математического аппарата. Материалы курса могут быть использованы для разработки и применения методов решения задач из многих областей знания, для построения и исследования математических моделей таких задач. Дисциплина является модельным прикладным аппаратом для изучения студентами образовательной программы «Социология и социальная информатика» математической компоненты своего профессионального образования.

В результате освоения дисциплины студент должен:

- Знать элементы линейной алгебры и матричных вычислений, теорию элементарных функций, методы дифференцирования и интегрирования, элементы аналитической геометрии, теорию вероятностей и математическую статистику.
- Уметь применить аппарат математического анализа и линейной алгебры в задачах прогнозирования различных показателей, при построении моделей, решении прикладных задач, использовать методы изучаемых разделов математики в профессиональных задачах.