

**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
Теория вероятностей и математическая статистика
(преподается на английском языке)**

для образовательной программы «Международный бизнес и менеджмент»
направления подготовки 39.03.01 «Менеджмент»
уровень бакалавриат

Разработчик программы

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Утверждена Академическим советом образовательной программы

«__» _____ 2018 г., № протокола _____

Академический руководитель образовательной программы

Джеффри Дейл Даунинг _____

Санкт-Петербург, 2018

Настоящая программа не может быть использована другими подразделениями университета и другими вузами без разрешения кафедры-разработчика программы

Course Syllabus

Title of the course	Probability and Statistics				
Title of the Academic Programme	Management				
Type of the course	Core(mandatory)				
Prerequisites	Linear Algebra and Calculus				
ECTS workload	4				
Total indicative study hours	Directed Study	Self-directed study	Total		
	90	138	228		
Course Overview	<p>Probability and Statistics has become an indispensable tool in almost every field of applied science, including social sciences. The goal of this course is to introduce the students to the basic mathematical notions, ideas and techniques needed to solve simple problems of Probability and to perform the statistical Data Analysis.</p> <p>The first module introduces the basic ideas and initial knowledge in Probability theory.</p> <p>The second module deals with the theory of random variables and Descriptive Statistics.</p> <p>In the third module the students will learn the basic notions of Mathematical Statistics.</p>				
Intended Learning Outcomes (ILO)	<p>When you have successfully completed this course you are expected to</p> <ul style="list-style-type: none"> - demonstrate an understanding of the basic concepts of Probability, Mathematical Statistics and Data Analysis; - be able to solve problems in Probability and Statistics and to perform preliminary Data Analysis. 				
Teaching and Learning Methods	The course consists of lectures (36 hours) and tutorials (54 hours). The tutorials involve problem solving.				
Content and Structure of the Course					
№	Topic / Course Chapter	Total	Directed Study		Self-directed Study
			Lectures	Tutorials	
1	Random events and Probability axioms	28	6	8	14
2	Bernoulli trials	20	4	6	10
3	Random variables and their description	20	4	4	12
4	Numerical characteristics of random variables	40	4	8	28
5	Basic Laws of Probability	24	4	4	16
6	Statistical sample and its description	16	2	4	10

7	Estimation theory: basic facts	28	4	6	18
8	Statistical hypothesis testing	32	4	8	20
9	Correlation and regression	20	4	6	10
Total study hours		228	36	54	138
Indicative Assessment Methods and Strategy		<p>Homework: You will be provided with weekly homework assignments. Collaboration on homework assignments is allowed and in fact encouraged, but each student is expected to write up his/her own solution. Homeworks will be selectively controlled and evaluated.</p> <p>Quizzes: There will be a quiz approximately every two weeks. The worst (or missed) quiz will be dropped at the end of the semester.</p> <p>Tests and Exam: There will be two control tests by 60 min written examination each, and a comprehensive Final Exam by 90 min written examination.</p> <p>Grading Policy: The graded activities include Class participation, Homework, Quizzes, Tests, and the Final Exam. The resulting cumulative (накопленная) mark (оценка) is evaluated by the formula:</p> $M_{cum} = 0.4 * M_{act} + 0.25 * T_1 + 0.35 * T_2 ,$ <p>where M_{cum} is the cumulative mark (rounded-up to the closest integer), M_{act} is the mark for activity which includes the class participation, the quizzes and selected home assignments (посещение, самостоятельные работы и выборочная проверка домашних заданий), T_1 and T_2 are the marks for the Test_1 and Test_2 (1-я и 2-я контрольные работы).</p> <p>The FINAL mark is evaluated by the formula:</p> $M_{fin} = 0.45 * M_{cum} + 0.55 * M_{exam},$ <p>where M_{exam} is the mark for the final exam.</p> <p>In case your cumulative mark is 9 or 10, you can get this mark automatically as a final mark without the exam.</p>			
Readings / Indicative Learning Resources		<p><u>Mandatory</u></p> <ol style="list-style-type: none"> Deep, R. Probability and Statistics [Electronic Resource] / Ronald Deep. - Elsevier Science & Technology, 2005. - 686 p. - Authorized access: https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=294324 - (Online Digital Library) 			

	<p>"ProQuest Ebook Central").</p> <p>2. Essentials of Statistical Inference [Electronic Resource] / G. A. Young [et. all]. - Cambridge University Press, 2005. - 237 p. - Authorized access: https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=237599 - (Online Digital Library "ProQuest Ebook Central").</p> <p><u>Optional</u></p> <p>1. Bruce, P. C. Introductory Statistics and Analytics: a Resampling Perspective [Electronic Resource] / Peter C. Bruce and Inbal Yahav. - John Wiley & Sons, Incorporated, 2015. - 309 p. - Authorized access: https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=1883957 - (Online Digital Library "ProQuest Ebook Central").</p> <p>2. Lefebvre, M. Applied Probability and Statistics [Electronic Resource] / Peter C. Bruce and Inbal Yahav. - NY: Springer, 2006. - 364 p. - Authorized access: https://proxylibrary.hse.ru:2066/10.1007/0-387-28505-9 - (Online Digital Library "Springer Ebooks").</p>																													
Indicative Self- Study Strategies	<table border="1"> <thead> <tr> <th data-bbox="529 958 1139 1014">Type</th> <th data-bbox="1139 958 1291 1014">+/-</th> <th data-bbox="1291 958 1495 1014">Hours</th> </tr> </thead> <tbody> <tr> <td data-bbox="529 1014 1139 1104">Reading for seminars / tutorials (lecture materials, mandatory and optional resources)</td> <td data-bbox="1139 1014 1291 1104">+</td> <td data-bbox="1291 1014 1495 1104">138</td> </tr> <tr> <td data-bbox="529 1104 1139 1160">Assignments for seminars / tutorials / labs</td> <td data-bbox="1139 1104 1291 1160">-</td> <td data-bbox="1291 1104 1495 1160">-</td> </tr> <tr> <td data-bbox="529 1160 1139 1249">E-learning / distance learning (MOOC / LMS)</td> <td data-bbox="1139 1160 1291 1249">-</td> <td data-bbox="1291 1160 1495 1249">-</td> </tr> <tr> <td data-bbox="529 1249 1139 1305">Fieldwork</td> <td data-bbox="1139 1249 1291 1305">-</td> <td data-bbox="1291 1249 1495 1305">-</td> </tr> <tr> <td data-bbox="529 1305 1139 1361">Project work</td> <td data-bbox="1139 1305 1291 1361">-</td> <td data-bbox="1291 1305 1495 1361">-</td> </tr> <tr> <td data-bbox="529 1361 1139 1417">Other (please specify)</td> <td data-bbox="1139 1361 1291 1417">-</td> <td data-bbox="1291 1361 1495 1417">-</td> </tr> <tr> <td data-bbox="529 1417 1139 1473"></td> <td data-bbox="1139 1417 1291 1473"></td> <td data-bbox="1291 1417 1495 1473"></td> </tr> <tr> <td data-bbox="529 1473 1139 1514">Preparation for the exam</td> <td data-bbox="1139 1473 1291 1514">-</td> <td data-bbox="1291 1473 1495 1514">-</td> </tr> </tbody> </table>	Type	+/-	Hours	Reading for seminars / tutorials (lecture materials, mandatory and optional resources)	+	138	Assignments for seminars / tutorials / labs	-	-	E-learning / distance learning (MOOC / LMS)	-	-	Fieldwork	-	-	Project work	-	-	Other (please specify)	-	-				Preparation for the exam	-	-		
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Academic Support for the Course	-																													
Facilities, Equipment and Software	-																													
Course Instructor	Yakov Yu. Nikitin																													

Course Content

1. Random events. Axioms of probability (Lecture 1, Discussion sections 1-2)
2. Classical definition of probability (Lecture 2, Discussion section 3).
3. Conditional probability, independent events, the law of total probability, Bayes' rule (Lecture 3, Discussion section 4)
4. Sequences of Bernoulli trials (Lectures 4-5, Discussion sections 5-7)
5. Discrete random variables. Distribution functions of discrete random variables. Examples (Lecture 6, Discussion section 8)
6. Continuous random variables. Cumulative distribution function, probability density function. Examples (Lecture 7, Discussion section 9)
7. Expected value of a random variable (Lecture 8, Discussion sections 10-12)
8. Variance of a random variable (Lecture 9, Discussion section 13)
9. The Law of Large Numbers (Lecture 10, Discussion section 14)
10. Central Limit Theorem (Lecture 11, Discussion section 15)
11. Descriptive statistics. Random samples and their main characteristics (Lecture 12, Discussion sections 16-17)
12. Random samples from normal distribution (Lecture 13, Discussion section 18)
13. Point estimation and interval estimation (Lecture 14, Discussion section 19-20)
14. Testing of statistical hypothesis, chi-squared test (Lectures 15-16, Discussion sections 21-24)
15. Basics of regression analysis, least squares method (Lecture 17, Discussion sections 25-26)
16. Basics of correlation analysis (Lecture 18, Discussion section 27)

Sample quiz

- #1. In the telephone number 135 -3_ - __ (7 digits) the last three digits were lost. Find the probability that:
- a. the three lost digits are the same number
 - b. exactly two out of the three lost digits coincide
- #2. Consider the experiment of rolling a die 10 times. Find the probability of having rolled:
- a. 1 no "6"s at all
 - b. 1 exactly 3 "6"s
 - c. 2 at least one "6"
- #3. Consider the experiment of rolling two dice. What is the probability that both times you rolled 5 if it is known that the sum of the results of both rolls is divisible by 5?
- #4. The first urn contains 1 white ball and 9 black balls, the second one contains 1 black ball and 5 white balls. You draw one ball from each urn (without replacement) and put all the remaining balls into the third urn. Now draw a ball from the third urn. What is the probability that it is white?

Assessment Methods and Criteria

Assessment Methods

Types of Assessment	Forms of Assessment	Modules			
		1	2	3	4
Formative Assessment	Tests			*	*
	Essay				
	Report/Presentation				
	Project				
	In-class Participation			*	*
	Other (write appropriate control forms for the course)				
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, broad background knowledge and correct solutions.
«Good» (6-7)	Shows strong evidence of preparatory research and broad background knowledge. Good oral expression but certain non-essential mistakes in the solutions of problems..
«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 solve basic problems and answer to follow-up questions.

Written Assignments (Essay, Test/Quiz, Written Exam, etc.)

Grades	Assessment Criteria
«Excellent» (8-10)	Has a clear argument, which addresses the topic and gives correct answers to the proposed problems. Writes clear comments to his solutions. Fully satisfies all the requirements of the task.
«Good» (6-7)	Responds to most aspects of the topic with an explicit argument. Covers the requirements

	of the task; may produce occasional errors and certain wrong calculations.
«Satisfactory» (4-5)	Generally addresses the task; the format may be inappropriate in places; display little evidence of formulae: 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.

In order to show the outcomes of self-study it is recommended:

- Make a plan for 3-5 presentation which will include topic, how the self-study was organized, main conclusions and suggestions and its rationale and importance.
- Supply the presentation with illustrations. It should be defined by an actual task of the teacher.

Recommendations for essay

An essay is a written self-study on a topic offered by the teacher or by the student him/herself approved by teacher. The topic for essay includes development of skills for critical thinking and written argumentation of ideas. An essay should include clear statement of a research problem; include an analysis of the problem by using concepts and analytical tools within the subject that generalize the point of view of the author.

Essay structure:

1. *Introduction and formulation of a research question.*
2. *Body of the essay* and theoretical foundation of selected problem and argumentation of a research question.
3. *Conclusion* and argumentative summary about the research question and possibilities for further use or development.

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.*

Аннотация на русском языке
Теория вероятностей и математическая статистика

Целями освоения дисциплины «Теория вероятностей и математическая статистика» являются овладение методами вычисления вероятностей случайных событий и распределений случайных величин, решением статистических задач оценивания, понятиями теории проверки статистических гипотез, уметь решать типовые практические задачи по этой дисциплине.

Материалы курса могут быть использованы для разработки и применения численных методов решения задач из многих областей знания и для построения и исследования математических моделей таких задач.

Дисциплина является фундаментальным аппаратом для изучения студентами-менеджерами математической компоненты своего профессионального образования.

В результате освоения дисциплины студент должен:

- знать методы решения задач на вычисление вероятностей событий и приемы работы с вероятностными характеристиками, базовые методы оценивания параметров и построения доверительных интервалов, умение выдвигать статистические гипотезы и делать правильные выводы о характере законов распределения наблюдений.
- уметь применить аппарат теории вероятностей в задачах формирования моделей и решении прикладных задач, используемых в курсах «Эконометрика» и «Теория игр»;
- иметь навыки в статистическом анализе экономической информации.