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 математики

Рабочая программа дисциплины
Математическая экономика и статистика

(преподается на английском языке)

для образовательной программы «Прикладная экономика и математические методы»
направления подготовки 38.04.01 «Экономика»
уровень магистратура

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Утверждена Академическим советом образовательной программы

«__» _____ 2019 г., № протокола_____

Академический руководитель образовательной программы

Ф.А. Ущев _____

Санкт-Петербург, 2019

Title of the course	**Mathematical Economics and Statistics**		
Title of the Academic Program	Master in "Economy" 38.04.01		
Type of Course	Obligatory course		
Prerequisites	Calculus, Probability theory, Optimization		
ECTS workload	6		
Total indicative study hours	Directed Study	Self-directed study	Total
	52	176	228
Course Overview	Course Mathematical Economics and Statistics is aimed for master students who are willing to obtain a basic knowledge of applied mathematics that is used in Economics. The course consists of Probability Theory, Statistics, Optimization and Dynamical Systems. Topics: 1. Basis of Probability Theory. 2. Statistics: estimation, confidence intervals, hypotheses testing, stochastic processes, time series. 3. Mathematical programming: problem statement, classification mathematical programming problems, linear programming, convex analysis, Kuhn-Tucker theorem. 4. Dynamical systems: difference equations, systems of difference equations, stochastic linear difference equations, basic methods for solving differential equations, dynamic optimization.		
Intended Learning Outcomes (ILO)	Knowledge of standard methods for solving problems of finite-dimensional optimization Being able to perform probabilistic and statistical calculations in standard formulations, give a meaningful interpretation of the results of calculations, process empirical and experimental data. Being able to investigate the local behavior and stability of nonlinear dynamical systems in the vicinity of a hyperbolic stationary point. Have the skills of probabilistic statistical thinking, have an idea about basic concepts of nonlinear dynamics.		
Teaching and Learning Methods	The course consists of lectures (28 hours) and seminars (24 hours). The seminars involve solving particular examples. At the end of first and the second section students will need to write a test.		

Content and Structure of the Course

№	Topic / Course Chapter	Total	Directed Study		Self-directed Study
			Lectures	Seminars	
	Section 1. Statistics				
1	Probability	20	2	3	15
2	Estimation	20	2	3	15
3	Confidence intervals	18	1	2	15
4	Hypothesis testing	15	2	3	10
5	Time series models	14	1	2	11
6	Markov chains	13	1	2	10
	Section 2. Mathematical programming				

7	Introduction	17	1	1	15
8	Linear programming	20	2	3	15
9	Nonlinear programming	25	4	6	15
	Section 3. Dynamics				
10	Linear Difference Equations	23	1	2	20
11	System of Linear Difference Equations	18	1	2	15
12	Dynamic Programming	25	2	3	20
Total study hours		**228**	**20**	**32**	**176**

Indicative Assessment Methods and Strategy	**Homework:** You will be provided with 2 homework assignments. **Tests and Exam:** There will be 2 tests – 80 min written examination each, and a comprehensive Final Exam – 80 min written examination. **Class Activity.** **Grading Policy:** The Final Grade is 0.12*(Test1)+0.12*(Test2)+0.12*(Homework1)+0.12*(Homework2)+0.12*(Activity)+ +0.4(Final Exam grade)
Readings / Indicative Learning Resources	Mandatory 1. Boos, D. D. and Stefanski, L. A. *Essential statistical inference: Theory and methods.* Electronic Resource]. Springer. 2013. - https://proxylibrary.hse.ru:2084/book/10.1007/978-1-4614-4818-1 2. Ljungqvist, L. and Sargent, T. J. *Recursive Macroeconomic Theory.* [Electronic Resource]. MIT Press, Cambridge, Massachusetts. 3 edition, 2012. - https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=3339507&query=Ljungqvist+Sargent++2000 Optional 3. Elaydi, S. *An Introduction to Difference Equations.* [Electronic Resource]. Springer-Verlag New York, 3 edition, 2005. - https://proxylibrary.hse.ru:2084/book/10.1007/0-387-27602-5 4. Heer, B. and Mauner, A. *Dynamic General Equilibrium Modeling: Computational Methods and Applications.* Electronic Resource]. Springer Publish-ing Company, Incorporated, 2nd edition, 2005/ - https://proxylibrary.hse.ru:2084/book/10.1007/b138909

Indicative Self- Study Strategies	**Type**	**+/–**	**Hours**
	Reading for seminars / tutorials (lecture materials, mandatory and optional resources)	+	126
	Assignments for seminars / tutorials / labs	-	
	E-learning / distance learning (MOOC / LMS)	-	
	Fieldwork	-	
	Project work	-	
	Other (please specify)	-	
	Preparation for the exam	+	50

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	-
Academic Support for the Course	Guidelines and recommendations for doing the course; guidelines and recommendations for self-study; samples of assessment materials are given to students and could be discussed during the consultation hours of the lecturer and with his assistants.
Course Instructor	Ovanes Petrosian

Annex 1

Course Content

Section 1. Statistics

1. **Probability (Lectures – 2 hours, Seminars - 3 hours, Self-directed study – 15 hours)**
   Set of events. Probability function. Tools for computing sample points. Conditional probability. Total probability. Bayes rule. Discrete random variables. Discrete random distribution: binomial, Poisson, geometric. Continuous random variables: normal, uniform, gamma, exponential, chi-squared. Basic laws of probabilities. Convergences. Law of large numbers. Central limit theorem.
2. **Estimation (Lectures – 2 hours, Seminars - 3 hours, Self-directed study – 15 hours)**
   Method of moments. Method of maximum likelihood. Relative efficiency. Common Unbiased Point Estimators. Goodness of a Point Estimator.
3. **Confidence intervals (Lectures – 1 hours, Seminars - 2 hours, Self-directed study – 15 hours)**
   Large Sample Confidence Intervals. Small Sample Confidence Intervals (normal). Sample size. Consistency. Sufficiency. The Rao–Blackwell Theorem.
4. **Hypothesis testing (Lectures – 2 hours, Seminars - 3 hours, Self-directed study – 10 hours)**
   Elements of Statistical Test. Common Large Sample Test. Type II Error Probabilities. Attained Significance Level. Neyman-Pearson Lemma. Likelihood Ratio Tests. Student's t-test. Chi-square Test.
5. **Time series models (Lectures – 1 hours, Seminars - 2 hours, Self-directed study – 11 hours)**
   Introduction to time series models. Stationarity. MA, ARMA, ARIMA processes. Dickey-Fuller test.
6. **Markov chains (Lectures – 1 hours, Seminars - 2 hours, Self-directed study – 10 hours)**
   Introduction to Markov chains. Markov property. Examples of Markov chains. Transition probability matrix. Steady-state analysis and limiting distributions

Section 2. Mathematical programming

7. **Introduction (Lectures – 1 hours, Seminars - 1 hours, Self-directed study – 15 hours)**
   Linear programming: introduction. Mathematical programming. Geometric Approach.
8. **Linear programming (Lectures – 2 hours, Seminars - 3 hours, Self-directed study – 15 hours)**
   Linear programming: Simplex algorithm. Dual problem.
9. **Nonlinear programming (Lectures – 4 hours, Seminars - 6 hours, Self-directed study – 15 hours)**
   Lagrange theorem. Implicit Function Theorem. The Lagrangean**.** Kuhn-Tucker conditions**.** Sufficient Conditions**.** Concave programming.

Section 3. Dynamics

10. **Linear difference equations (Lectures – 1 hours, Seminars - 2 hours, Self-directed study – 20 hours)**
    Introduction to linear difference equations. First order linear difference equations. Solution Algorithm. Steady State and Stability. Linear Difference Equations of Order p. Stability.
11. **System of linear difference equations (Lectures – 1 hours, Seminars - 2 hours, Self-directed study – 15 hours)**
    Introduction to systems of linear difference equations. First order system of linear difference equations. Stability. Two dimensional systems of linear difference equations.
12. **Dynamic programming (Lectures – 2 hours, Seminars - 3 hours, Self-directed study – 20 hours)**
    Problem Statement in dynamic programming. Bellman equation. Examples of problems of dynamic programming

Annex 2

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	*	*		
	Homeworks	*	*		
Interim Assessment (if required)	Assignment (e.g. written assignment)				
Summative Assessment	Exam		*		

Assessment Criteria

Written Assignments (Tests, Homeworks, 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.

for persons with muscle-skeleton disorders: a printed text; an electronic document; audios; individual assignments and advising.

Annex 3

Аннотация на русском языке
Математическая экономика и статистика

Курс «Математическая экономика и статистика» входит в базовую часть учебного плана МП «Прикладная экономика и математические методы» и предназначен для формирования кругозора магистрантов с точки зрения знакомства с экономическими моделями и приложениями математических методов в различных разделах экономики. Курс знакомит с элементами теории вероятностей, статистики, оптимизации и динамических систем.

Темы:

1. Основы теории вероятностей.
2. Статистика: оценка, доверительные интервалы, проверка гипотез, случайные процессы, временные ряды.
3. Математическое программирование: постановка задачи, классификация задач математического программирования, линейное программирование, выпуклый анализ, теорема Куна-Такера.
4. Динамические системы: разностные уравнения, системы разностных уравнений, стохастические линейные разностные уравнения, основные методы решения дифференциальных уравнений, динамическая оптимизация.