

## **Syllabus for ELEMENTS OF STATISTICS (Third and Fourth Semesters)**

**Lecturer** Anatoly A. Peresetsky  
**Classteachers** A. Kiselev, A. Zasorin, M. Kovalev, A. Trubnikova, A. Shelike

### **Course description**

Elements of statistics is a two-semester course for second year ICEF students. This is a course for students specializing in economics. The course is taught in Russian and English.

Basic ideas of statistics, such as descriptive statistics, population and sample, parameters estimation, testing statistical hypotheses etc, are studied in the course, as well as elements of probability theory which are necessary for understanding the course.

### **Prerequisites**

Prerequisites are Calculus (functions of several variables, partial derivatives, integrals, maximum of functions), and elements of Linear algebra (vectors, matrices, linear equations).

### **Course objectives**

The main objective of the course is to give a sound and self-contained (in the sense that the necessary probability theory is included) description of classical or mainstream statistical theory and its applications.

The students should learn to carry out a simple analysis of data (to find mean, median, standard deviation and other descriptive statistics), to present the data graphically (histograms, stem plots). They should understand the differences between population and sample, and theoretical and sample characteristics. Since it is not worth while to teach Statistics without elements of probability theory, studying its basic notions and results is a part of the course. Students should understand what probability space, random event, probability of an event are. They should know how to calculate probabilities of complex events, solve elementary combinatorial problems, use the full-probability and Bayes formulas. The students should have a clear understanding of what a random variable and its distribution are.

The students should learn to formulate and solve basic problems of statistics, such as parameters estimation, statistical hypotheses testing, correlation analysis, analysis of variance, Spearman correlation, contingency tables. One of the course aims is to prepare students for further studying of Econometrics on the basis of studying simple and multiple regression models.

The course is not mathematically rigorous. Proofs, and even exact statements of results, are often not given. The problems are an essential part of the course. A serious effort has been made in the problems to illustrate the variety of ways in which the theory may be applied.

### **Learning Outcomes**

By the end of the course the students should have gained an understanding of the underlying theory and an ability to carry out relevant calculations and apply standard methods in practice

In the end of the year students should pass an UL exams "Statistics-1" and "Statistics-2".

### **Teaching methods**

The following methods and forms of study are used in the course:

- lectures (2 hours a week)
- classes (2 hours a week)
- self study

- weekly written home assignments (to be graded)
- teachers' consultations

In total the course includes 68 hours of lectures and 68 hours of classes.

### **Main reading**

Newbold P. Statistics for Business and Economics. Prentice-Hall, (N). 6<sup>th</sup> edition, 2007.

Elements of Statistics, Study Guide. University of London.

Statistics 2, Study Guide. University of London.

Katyshev P.K., Peresetsky A.A., Problem sets with solutions in Probability and Statistics for Economists. 3rd edition. МИЭФ, 2010.

### **Additional reading**

Айвазян С. А., Мхитарян В. С. Теория вероятностей и прикладная статистика. ЮНИТИ. Москва, 2001.

Гмурман В. Е. (2011). Теория вероятностей и математическая статистика? 10-е издание.. М., ЮРАЙТ.

Гмурман В. Е. (2009). Руководство к решению задач по теории вероятностей и математической статистике, 9-е издание. М., Высшее образование.

Шведов А. С. (2005). Теория вероятности и математическая статистика? 2-е издание, ВШЭ.

Hogg R. V. and Tanis E. A. (2010). Probability and Statistical Inference, 8<sup>th</sup> edt., Prentice Hall.

Johnston A. R. and Bhattacharyya G. K., (2005). Statistics. Principles and Methods. 5th edition, Wiley, 1996.

Wackberly D. D., Mendenhall III W., and Scheaffer R. L. (2008). Mathematical Statistics with Applications, 7th edition. Thomson Learning

### **Internet Resources**

[http://www.londoninternational.ac.uk/current\\_students/programme\\_resources/lse/exam\\_archive/exam\\_papers\\_2010.shtml](http://www.londoninternational.ac.uk/current_students/programme_resources/lse/exam_archive/exam_papers_2010.shtml)

<http://www2.gsu.edu/%7Edscbms/ibs/qcontent.html>

<http://www.math.uah.edu/stat/>

<http://www.math.yorku.ca/SCS/Gallery/>

[http://www.bbn-school.org/us/math/ap\\_stats/applets/applets.html](http://www.bbn-school.org/us/math/ap_stats/applets/applets.html)

<http://wise.cgu.edu/links/applets.asp>

### **Assessment**

Home assignments

(weekly, distributed in printed form at the lectures, solutions are distributed at the next lecture, two problems from each home assignments are graded. No email, fax, Xerox submissions are allowed, deadline for submission is the beginning of the next lecture).

Quizzes

Midterm 1 (fall)  
 Exam (winter)  
 Midterm 2 (spring)  
 London exams (spring)

**Grade determination:**

Approximate formula for the final grade in HSE program in statistics is given at the table

Component	Weight
Home assignments and quizzes	0.14
Midterm 1	0.14
Exam (winter)	0.14
Midterm 2 (spring)	0.21
Max(London Stat-1, London Stat-2)	0.37
<i>Extra adds to the score</i>	
For the activity in class (for each point)	~0.80*
Misprints (for each misprint)	~0.80*

*\*to be revised.*

If a student get less than 25 point at the spring midterm exam it means she/he FAILED, and have to pass a Make-up, doesn't matter what the final score or London exam is.

**Course outline**

**1. Primary data analysis**

- Graphical presentation of one variable data. Dotplot. Steamplot. Histogram.
- Data irregularities. Outliers. Clusters. Histogram's shape.
- Descriptive statistics. Measures of central tendency. Arithmetic mean, median, mode, geometric mean. Measures of variation. Range, sample standard deviation, interquartile range, mean absolute deviation, mean relative deviation.
- Descriptive statistics and linear transformation of data.
- Measures of the relative standing. Quartiles. Percentiles. Z-score.
- Grouped data.

(N Ch.1, 2)

**2. Elements of Probability theory**

- Probability. Outcome space. Events algebra. Independent events. Mutually exclusive events. Conditional probability. Full probability formula. Bayes' formula.
- Discrete Random Variable. Probability density function (p.d.f.). Mathematical Expectation. Variance. Standard deviation. Binomial distribution.
- Continuous random variables. Distribution function. Probability density function. Uniform distribution. Normal distribution.
- Law of large numbers. Normal approximation to binomial distribution. Linear transformation of a random variable.
- Two random variables. Covariance. Correlation. Uncorrelated and independent random variables. Mean and Variance of a linear combination of two random variables.

(N Ch.3, 4, 5)

**3. Elements of Mathematical Statistics**

- Random Samples. Duality of Interpretation. Estimation of population parameters. Sample mean and sample variance. Mean and variance of the sample mean. Estimation of proportions.
- Point Estimation. Properties of the estimators. Unbiasedness, efficiency, consistency. Estimators for mean and variance.
- Maximum Likelihood.
- Interval estimation. Confidence intervals. Estimation of the mean. Normal approximation for large samples, small samples (Student distribution). Difference of two means. Proportions.
- Hypothesis testing. Hypothesis testing with confidence intervals. Hypothesis testing with test-statistics. Two-sided and one-sided p-values.
- Chi-square goodness-of-fit test. Contingency tables.

(N Ch.6–9, 11)

#### 4. Models of simple regression

- X-Y graph. Line fitting. Ordinary Least Squares.
- Transformations of regressors.
- Outliers.
- Forecasts.
- Regression residuals. Residuals and errors.
- Statistical properties of the estimators. Hypothesis testing.
- (N Ch.12)

#### 5. Analysis of variance (ANOVA)

- One-factor analysis of variance.
- Two-factors analysis of variance.
- Confidence intervals.

(N Ch.15)

#### Distribution of hours

No	Topic titles	TO-TAL (hours)	Contact hours		Self-study
			i. e.		
			Lectures	Classes	
1.	Primary data analysis	26	6	6	14
2.	Elements of Probability theory.	80	20	20	40
3.	Elements of Mathematical Statistics.	110	30	30	50
4.	Models of simple regression	28	6	6	16
5.	Analysis of variance.	26	6	6	14
	<b>Total:</b>	<b>270</b>	<b>68</b>	<b>68</b>	<b>134</b>