International Information Technology University JSC

Faculty of Information Technology

Department of Mathematical and Computer Modeling

Approved
Vice-Rector for Academic and Educational
Affairs of IITU JSC, PhD
Umarov T.F.
«28» 08 2020

SYLLABUS
(ACADEMIC PROGRAM)

Course: MS 3223 Mathematical Statistics

Major: 5B070500 Mathematical and computer modeling

Educational program: Data Science in Engineering

Year:3 **Semester:**5 **Number of credits:** 3ECTS

Lectures:15 hours

Practice classes: 15 hours

T/SIS: 60 hours

Total: 90 hours

Final assessment form: Examination

Almaty 2020

Academic program of the course « MS 3223 Mathematical Statistics » has been reviewed at the meeting of Mathematical and Computer Modeling department.

Minutes №. 1 dated «17» August 2020

Head of the Department _____ Ydyrys A.Zh., Assistant Professor,PhD

Author _____ Nartova D.S., Associate Professor, PhD

The working academic program was approved at the meeting of the Educational and Methodological Board of JSC "IITU"

Minutes № 1 dated «28» August 2020

Head of the Department for Academic Affairs _____ Mustafina A.K.

signature

1. GENERAL INFORMATION	
Faculty	Information Technology
Major code and title	5B070500 Mathematical and Computer Modeling
Educational program code and title	Data Science in Engineering
Year, semester	3 year, 5 semester
Subject category	Compulsory Elective Profiling
Number of credits (ECTS)	3 ECTS
Prerequisites	
Postrequisites	Financial Mathematics, Derivatives
Lecturer	Nartova D.S.PhD, Associate professor #807, d.nartova@edu.iitu.kz Office hours: Friday, 12.00-13.00

2. GOALS, OBJECTIVES AND LEARNING OUTCOMES OF THE COURSE

The course goal is

The learning objectives of the course "Statistics 1" are to familiarize students with essential tools in probability theory and mathematical statistics. Students will gain skills in combinatorial analysis, develop basic theorems of probabilities via axioms of probability, conditional probability, repetition of trials, random variables and their laws of distribution, basic characteristics of random variables, the law of large numbers and limiting theorems, elements of mathematical statistics.

The objectives of the course

1. To gain a basic understanding of fundamental statistical theories
2. To apply statistics to real finance problems
3. To familiarize with statistics terminology

Learning outcomes of the course

- Design data collection, analyze, interpret and draw conclusions from those analyses.
- Demonstrate ability of applying probability theory and elements of combinatorics as a measure of reliability for statistical inferences.
- Develop ability of constructing statistical inferences based on concept of probability distribution of discrete and continuous random variables.
- Provide a measure of reliability for point estimates, confidence interval estimates based on significance level concept.
- Correctly identify and apply the appropriate hypotheses test when making statistical decisions.
- Establish statistical significance for estimates of population parameters using confidence intervals and hypothesis tests.
- Formulate and specify a simple regression model with parametrization and verification maintenance in order to predict and interpret the explored population factor.

3. Course description

The main topics covered in the course include the following: combinatorial analysis, axioms of probability, conditional probability, independent events, random variables (both discrete and continuous) and their laws of distribution, limit theorems, and introduction to mathematical statistics.

The course develops creative thinking, ability of individual perceptive activity; to generate abilities and skills of holding experimental investigations and processing their results, ability to use obtained skills for applied tasks of the future specialty.

4. Course policy

Students are forbidden to:

- come to class without a textbook or a printout of an e-book from dl.iitu.kz. A student without a textbook gets the mark "0" for class participation;
- submit any assignment after the deadline. After deadline assignments will be accepted, given that for each late day submission will be -10%.
- cheating. Plagiarized papers will not be graded;
- be late for classes. Being tardy three times amounts to one absence;
- retake any tests, unless there is a valid reason for missing them;
- use mobile phones in class;

Students should always

- be appropriately dressed (formal/semi- formal styles are acceptable);
- show consideration for and mutual support of teachers and other students;
- let the lecturer know of any problems arising about their studies.

Online classes will be on platforms MS Teams, DL and Zoom.

5. LITERATURE

Basic literature:

1. Cambridge International AS and A Level Mathematics, Statistics, Sophie Goldie Series Editor: Roger Porkess, Hodder Education, An Hachetter UK Company.
2. Statistics for Business and Economics, 8th Edition, Paul Newbold, William Carlson , Betty Thorne, ©2013 ,Pearson.
3. B.V. Gnedenko "The Theory of Probability".
4. S. Ross "Introduction to Probability and Statistics for Engineering".
5. W. Feller "An Introduction to probability theory and its applications".
6. R. Walpole, etc. "Probability and Statistics for engineers and scientists".
7. https://www.coursera.org/programs/international-information-technologies-university-on-coursera-x7m8z/browse?=&productId=ZNeGqEC2EeWC4g7VhG4bTQ&productType=course&query=Statistics&showMiniModal=true

Supplementary literature:

1.Danko P.E., Popov A.G., Kozhevnikova T.Ya., Higher mathematics in exercises. The fifth issue, revised. – Moscow: «Higher school», 1999, part 2 (in Russian).
2.Olav Kallenberg, Foundations of Modern Probability, second edition, Springer Series in Statistics, 2002, 650 pages.

6. Course schedule

Week/ date	Course topics	References	Lectures (1 h/w)	Practical sessions(1 h/w)	TSIS (1 h/w)	SIS (3 h/w)
1	Introduction to Statistics. Graphical presentation of qualitative and quantitative data	Ch. 1 1.1-1.6	1	1	1	3
2	Numerical measures of central tendency for grouped and ungrouped samples. Sampling measures of variability for grouped and ungrouped samples	Ch.2 2.1-2.6	1	1	1	3

3	Elements of combinatorics	Ch.3 3.1-3.7	1	1	1	3
4	Elements of probability theory	Ch.3 3.1-3.22	1	1	1	3
5	Random variables. Classification. Discrete random variables.	Ch.4 4.1-4.6	1	1	1	3
6	Continuous random variables.	Ch.5 5.1-5.2	1	1	1	3
7	Normal distribution	Ch.5 5.3	1		1	3
7	Mid term			1		
8	Sampling Distributions	Ch.6 6.1-6.3	1	1	1	3
9	Point and interval estimators	Ch.7	1	1	1	3
10	Hypotheses testing. Tests and confidence interval for a single sample	Ch.7 8.1-8.6	1	1	1	3
11	Tests and confidence intervals for two samples	Ch.9 9.1-9.2	1	1	1	3
12	Small and Large -sample inferences	Ch.9 9.3-9.4	1	1	1	3
13	Simple linear regression	Ch.11 11.1-11.7	1	1	1	3
14	Simple linear regression	Ch.13 13.1-13.4	1		1	3
14	End term			1		
15	Review for Final Exam (cumulative)	Ch.13	1	1	1	3
	Total hours:	**90**	**15**	**15**	**15**	**45**

7. List of topics/ assignments for practice classes

№	Topic Title	Number of hours	References	Form of reporting	Deadline
1	2	3	4	5	6
1	Problems of Statistics, basic conceptions in Statistics	1	[1]-[6]	Submission of PA	Week 1
2	Sampling measures of variability (range, variance, standard deviation)	1	[1]-[6]	Submission of PA	Week 2
3	Elements of combinatorics (counting principals, generalized counting principal;	1	[1]-[6]	Submission of PA	Week 3

	number of permutations and combinations)				
4	Elements of probability theory (main definitions: random experiment, event; classical approach in probability introduction; geometrical distribution; basic axioms of probability; operations with events: union, intersection and compliment; events classifications: mutually inclusive or mutually exclusive; dependent or independent; conditional probability)	1	[1]-[6]	Submission of PA	Week 4
5	Random variables. Classification. Discrete random variables.	1	[1]-[6]	Submission of PA	Week 5
6	Continuous random variables	1	[1]-[6]	Submission of PA	Week 6
7	Normal distribution	1	[1]-[6]	Submission of PA	Week 7
8	Sampling Distributions	1	[1]-[6]	Submission of PA	Week 8
9	Point and interval estimators	1	[1]-[6]	Submission of PA	Week 9
10	Hypotheses testing. Tests and confidence interval for a single sample	1	[1]-[6]	Submission of PA	Week 10
11	Tests and confidence intervals for two samples	1	[1]-[6]	Submission of PA	Week 11
12	Small and Large -sample inferences	1	[1]-[6]	Submission of PA	Week 12
13	Simple linear regression	1	[1]-[6]	Submission of PA	Week 13
14	Inferences for parameters of the model	1	[1]-[6]	Submission of PA	Week 14
15	Hypothesis verification	1	[1]-[6]	Submission of PA	Week 15

8. List of topics/assignments for Student Independent Study

Proper organization of student's independent study is the key to the formation of skills in mastering, learning, assimilation and systematization of acquired knowledge, ensuring a high level of academic performance in the learning process

№	Topic/Assignment title	Number of hours	References	Form of reporting	Deadline
1	2	3	4	5	6
1	Time value of money	9	Academic literature	Discussion	Week 3
2	Net present value. IRR	9	Academic literature	Discussion	Week 6
3	2008 GFC	9	Articles, video lectures online	Discussion	Week 9
4	Risk and return	9	Academic literature	Discussion	Week 12
5	Options	9	Academic literature	Discussion	Week 15

9. System for evaluating student performance in a discipline:

Period	Assignments	Number of points	Total
1st attestation	Quiz 1 Quiz 2 Midterm	25 25 50	100
2nd attestation	Quiz 3 Quiz 4 End of term	25 25 50	100
Final exam	Exam	100	100
Total	**0,3*1stAtt+0,3*2ndAtt+0,4*Final**		**100**

*If the number of absences exceeds 20%, student will be automatically scheduled for a Retake (summer semester)

Evaluation criteria for course elements:

- Quizzes from #1 to #4:

  Estimates for quizzes are put in proportion to the number of correctly solved problems.
- Individual homework from #1 to #12:

  If you have done all the tasks from the homework without an error-5

  If you have done all the tasks, but there are some shortcomings-4

  If you have done more than half of the tasks without an error-3

  If you have done more than half of the tasks with errors-2

  If you have done less than half of the tasks without an error-1

  If you have done less than half with errors or have not done at all-0
- Midterm:

  1. correctly found the simple linear regression model
  2. Properties of OLS, units of measurement
  3. Gauss Markov Assumption
  4. Multiple regression analysis-estimation
- End of term:

  1. simple linear regression model
  2. multiple regression model
  3. dummy variable

4. regression and causality
5. regression with time series
6. Dynamic regression
7. OLS estimation

- Exam:
- 2. multiple regression model
- 3. dummy variable
- 4. regression and causality
- 5. regression with time series
- 6. Dynamic regression
- 7. OLS estimation

Achievement level as per course curriculum shall be assessed according to the evaluation chart adopted by the academic credit system:

10. Assessment criteria:

Letter Grade	Numerical equivalent	Points (%)	Traditional system assessment	General description of grading criteria
A	4,0	95-100	Excellent	The student has knowledge of the subject in the full scope of the curriculum, understands the discipline deeply enough; shows a high level of knowledge that exceeds the volume provided by the syllabus, gives an exhaustive answer
A-	3,67	90-94		The student has knowledge of the subject in the full scope of the curriculum, understands the discipline deeply enough; gives an exhaustive answer
B+	3,33	85-89	Good	The student shows a complete, well-founded knowledge of the subject, but the answers did not always highlight the main idea, rational methods of calculation were not always used; the answers were mostly brief and sometimes unclear.
B	3,0	80-84		
B-	2,67	75-79		
C+	2,33	70-74		
C	2,0	65-69	Satisfactory	The student demonstrates sufficient knowledge of the subject, but without proper depth and justification, the answers are unclear and without proper logical sequence.
C-	1,67	60-64		
D+	1,33	55-59		
D	1,0	50-54		
FX	0,5	25-49	Unsatisfactory	The student demonstrates insufficient knowledge of the subject, positive answers were not given to individual questions.

F	0	0-24		The student demonstrates a very low level of knowledge of the subject.

11. Assessment and evaluation materials (exam questions)

Assessment is administered continuously throughout the course. The students are rated against their performance in **continuous rating** administered throughout the semester (credited 60%) and **summative rating** done during the examination session (credited 40%), total **100%. Continuous rating** is students' on-going performance in class and independent work. Class work is assessed for attendance, homework and in- class assessments.

Teaching methodology

Theory classes:

- lectures developing the theoretical aspects of the subject
- practical classes aimed at applying theory to problems.

Workshop classes:

practical classes in which students solve problems in groups or individually.

Class work is a combination of theoretical basics and practical application of calculus.

Homework assignments consisting of textbook exercises will be made on a regular basis. Completing the homework is important for success in the course.

TSIS (Teacher Supervised Student Independent Study) ***-comprises several exercises to be done by students independently and checked by teacher.***

SIS (Student Independent Study) comprises exercises to be done by students independently.

Mid-term is writing work in class, consisting of several exercises.

Final examination *is an attainment test designed to monitor the students' academic performance, comprising 80-90 tasks.*

Course policies and instructor's expectations of students:

Statement: This class is a partnership. We each have our obligations so that maximum learning and understanding takes place. You are recommended to read the relevant material before class. Our in-class discussions will be more interesting and helpful if you have read the text before class.

Class attendance: You are expected to attend all classes and be on time. Attendance will be taken during lectures and tutorial sessions. Although attendance is not included into the evaluation scheme, it might be taken into consideration in case of poor performance. According academic policy in case student misses at least 20% classes he/she can not be permitted to final exam. Please be advised that material missed during an absence is your responsibility.

Academic Discipline Rules: IITU requires all students to adhere to high standards of integrity in their academic work. Home assignments are to be submitted on the due dates only.

Activities such as cheating and plagiarism are not condoned by the university. Students involved in such activities are subject to serious disciplinary action. Cheating includes the giving or receiving of unauthorized assistance on quizzes, examinations or written assignments from any source not approved by the instructor. For full information on Academic Discipline Rules please refer to the Academic Policy of IITU.

Sample exam card questions:

1. A class consists of 460 female and 540 male students. The students are divided according to their marks

	Passed	**Did not pass**
Female	**400**	**60**
Male	**440**	**100**

If one person is selected randomly, the probability that it did not pass given that it is female is:
a. 0.06
b. 0.13
c. 0.15
d. 0.101

2. MGF of the Poisson distribution

$$M(t) = \exp\left\{\mu t + \frac{\sigma^2 t^2}{2}\right\}$$

- $e^{\lambda(e^t - 1)}$
-
- lambda

$$\left[pe^t + (1-p)\right]^n$$