

# Mathematical Statistics

Syllabus Number

1A304

Special Subjects

Elective 2 credit

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## 1. Course Description

Mathematical statistics are fundamental knowledge essential to understand or to estimate the data collected from various fields. At the beginning of this course, the student will study descriptive statistics so as to understand the characteristics of statistical data. Then, in order to prepare the learning of inference statistics, students will study basic probability theories, concepts of probability distributions, several discrete probability distributions, the concepts of continuous probability distributions and various important distributions for mathematical statistics. Finally, the students will learn the inferences and tests for the first step for the inference statistics.

This subject corresponds to the diploma policy DP2 and DP3.

## 2. Course Objectives

According to the diploma policy DP2 and DP3, students will obtain knowledge of the mathematics as a basic major subject for common basic academic skills, and obtain knowledge of the mathematics necessary to obtain the School Teacher's License for mathematics.

In details, students will be able to explain and calculate the number of cases, the concepts of discrete and continuous probability distributions, and the inferences and tests to obtain basic mathematical statistics.

## 3. Grading Policy

Those who attend 10 or more lectures out of all 15 lectures will be given the qualifications of the regular examinations. The overall grade of this course will be decided based on the sum of total 100 points of the midterm exam (40 points), the final exam (40 points), and the score of exercises (20 points), and those whose grade is 60 or more will pass.

The score of exercises will be proportional to the number of the passed exercises submitted before each due date, and the maximum score of exercises is 20.

For feedback, the answer of the exercise will be explained right after the submission, and the exercise will be corrected and returned in the offered session. Each due date of the exercise is the date of the next class. No delay of submitting the exercises are allowed.

## 4. Textbook and Reference

Textbook

Keishi Baba Probability and statistics campus seminar ver.6, ISBN:978-4-86615-161-8. Mathema Publishing

The slides shown in the class and the exercises will be open to LMS.

Reference

Department of Statistics, College of Arts and Sciences, the University of Tokyo. Basic statistics I, Introduction of the statistics, ISBN: 978-4130420655. University of Tokyo Press

Sonoko Ishimura "Yasashiku manaberu toukeigaku", ISBN: 978-4320018082. Kyoritsu Shuppan

Heidi Koderu "Meikai-enshuu, Mathematical statistics", ISBN:978-4-320-01381-0 Kyoritsu Shuppan

Barbara Illowsky, Susan Dean, et al. "Introductory Statistics" (Digital version: ISBN-13: 978-1-947172-05-0) OpenStax, which is managed by Rice University.

<https://openstax.org/details/books/introductory-statistics>

## 5. Requirements(Assignments)

For preparations of each class, students must read and organize the contents, and must go through the example questions in the relevant part of the textbook (about 1.0 hour).

For reviews of each class, students must do the exercises open to LMS (about 2.0 hour). If the content is hard for you, you can think about it together with other participants. Do not hesitate to ask the teacher in charge.

This course handles the fundamental aspects of probability. Therefore, if you are not good at probability, you should review the probability at senior high school carefully. Furthermore, calculus will be applied in the latter half of this course. Therefore, you should review calculus carefully.

During this course, you should analyze actual data with spread sheet software.

Refer to "Introductory Statistics" in 4. References, that is an open resource for university education for self-learning materials, to compare Japanese and English expressions for statistics.

## 6. Note

Students must prepare a scientific calculator without a communication function for doing the exercises and the regular examinations.

LMS will be used for this course.

## 7. Schedule

- [1] Introduction and descriptive statistics (1) case of one variable: After the digest of this course, statistics such as average, variance, etc. will be explained. The relevant part of the textbook is Sec. 6.1.
- [2] Descriptive statistics (2) correlation relation of two variables: Correlation relation in the statistics and its calculation will be explained. The relevant part of the textbook is correlation coefficient of Sec. 6.2.
- [3] Descriptive statistics (3) regression of two variables: Regression and its calculation will be explained. The relevant part of the textbook is regression of Sec. 6.2.

- [4] Basic theory of probability (1) number of cases and definition of probability: Reviewing probability at senior high school and the advanced concepts of probability will be explained. The relevant parts of the textbook are Sec. 1.1 and 1.2.
- [5] Probability distribution (1) what is discrete probability?: Reviewing probability at senior high school and the advanced concepts of discrete probability, expectation, variance, etc. will be explained. The relevant parts of the textbook are random variables, expectation and variance of Sec. 1.3.
- [6] Probability distribution (2) various discrete probability: discrete probabilities such as binomial distribution and Poisson distribution will be explained. The relevant parts of the textbook are binomial distribution of Sec. 1.3, and Sec. 4.1.
- [7] Basic theory of probability (2) Bayes theorem and independence of events: The concept of a posteriori probability through Bayes theorem and independence of events will be explained. The relevant parts of the textbook are Bayes theorem and independence of events of Sec. 1.2.
- [8] Conclusions of the former half and midterm exam: The degree of understanding from the 1st class to the 7th class will be examined.
- [9] Probability distribution (3) what is continuous probability?: The advanced concepts of continuous probability from discrete probability, and how to calculate its expectation and variance using integrals will be explained. The relevant part of the textbook is Sec. 2.1.
- [10] Probability distribution (4) continuous probability distribution and normal distribution: Reviewing continuous probability, and normal distribution as one of the important examples (especially standard normal distribution) will be explained. The relevant parts of the textbook are Sec. 2.1, a change of variables of Sec. 2.2, and Sec. 4.2.
- [11] Probability distribution (5) normal distribution and central limit theorem: Reviewing normal probability, central limit theorem and probability distributions with two or more variables will be explained. The relevant parts of the textbook are Sec. 4.2, Sec. 4.3, and Chapter 3.
- [12] Probability distribution (6) various distributions (for inferences and tests), population and sample: Various distributions such as chi-squared distribution, t distribution, F distribution, etc., the concept of population and sample, which are important for the inference statistics, unbiased estimators, etc. will be explained. The relevant parts of the textbook are exponential distribution of Sec. 2.2, Chapter 5, and Sec. 7.1.
- [13] Inferences and tests (1) point estimation and interval estimation: Point estimation and interval estimation will be explained as the introduction of the inference statistics. The relevant part of the textbook is Chapter 7.
- [14] Inferences and tests (2) tests: The concept of tests to decide statistically will be explained as the introduction of the inference statistics. The relevant part of the textbook is Chapter 8.
- [15] Integrated practice: The contents from the 8th class to the 14th class will be reviewed using exercises. Especially, the procedure of tests will be reviewed carefully to surely understand the concept of tests.