

# Nankai University

## Undergraduate Course Syllabus

### 1. Course Information

<b>Course Name</b>	Mathematical Statistics						
<b>Course Number</b>	FINA0110						
<b>Course Type</b>	<input type="checkbox"/> Compulsory course -- Liberal Arts Education <input type="checkbox"/> Elective course -- Liberal Arts Education <input checked="" type="checkbox"/> Compulsory course -- Professional <input type="checkbox"/> Elective course -- Professional						
<b>Credit</b>	2.5	<b>Lecture Hours</b>	48	<b>Practicum Hours</b>	0	<b>Total Hours</b>	48
<b>Grading Structure</b>	<input checked="" type="checkbox"/> Percentage system <input type="checkbox"/> Pass/Fail System						
<b>Course Provider</b>	School of Finance						
<b>Prerequisite courses</b>	Calculus, Linear Algebra, Probability						
<b>Course Director</b>	Min Song, Haibin Wang, Jiening Pan						
<b>Course Textbooks and Reference Materials</b>							
<b>Textbooks</b>	<b>Authors</b>	<b>Title</b>	<b>Publishing House</b>	<b>ISBN</b>			
	David R. Anderson; Dennis J. Sweeney; Thomas A. Williams; Jeffrey D. Camm; James J. Cochran	Statistics for Business & Economics	Cengage Learning	9781337901062			
<b>Reference Materials</b>	<b>Authors</b>	<b>Title</b>	<b>Publishing House</b>	<b>ISBN</b>			
	Junping Jia; Xiaoqun He; Yongjin Jin	Statistics	China Renmin University Press	9787300253510			
	Xiaotong Zhang	Applied Econometrics	China Machine Press	9787111265757			

## 2. Prerequisite Description

- **Calculus:** Before selecting this course, one must have earned the credit of one of these courses:
  - Calculus;
  - Advanced mathematics;
  - Analytics.

Student should gain basic knowledge of:

- Limits and continuity;
- Differentiation;
- Derivatives;
- Integration;
- Polar coordinates;
- Infinite sequences and series;
- Partial derivatives;
- Multiple integrals.

- **Linear algebra:** Before selecting this course, one must have earned the credit of one of these courses:

- Linear algebra;
- Advanced algebra.

Student should gain basic knowledge of:

- Vectors and matrices;
- Solving Linear Equations;
- Four Fundamental Subspaces;
- Orthogonality;
- Determinants;
- Eigenvalues and eigenvectors;
- The singular value decomposition (SVD);
- Linear transformations.

- **Probability:** Before selecting this course, one must have earned the credit of one of these courses:

- Probability;
- Advanced probability.

Student should gain basic knowledge of:

- Combinatorics;
- Independent, mutually exclusive;
- Bayes Theorem;
- Random variables, probability density functions and cumulative distribution functions;
- Expected value and higher moments, mode, median, and percentile;
- Variance, standard deviation, and coefficient of variation;
- Moment generating function, cumulant generating function;
- Sum of independent random variables;
- Joint probability functions, marginal probability distributions;
- Covariance and the correlation coefficient;
- Law of large numbers, central limit theorem.

### 3. Course Introduction

As a science of methodology studying on how to collect, clean, display and analyze data, Mathematical Statistics aims to teach students how to use scientific statistical theories and methods to understand quantitatively the regularity of development and the changes of objective things. This course will provide students with basic knowledge, theory and methods to lay the foundation for other courses and related work. This course is mainly for second-year undergraduate students. The main content of the course includes:

- Random sampling and several important distributions;
- Point estimation including moment approach, percentile matching, and maximum likelihood;
- Bias, variance, MSE, Fisher information matrix, Cramér-Rao lower bound, consistency, efficiency, and UMVUE;
- Confidence intervals estimation, including the mean of samples from a normal population, differences of means of samples from two normal population, variances, and proportions;
- Neyman-Pearson lemma, significance and power, and information criteria;
- Hypothesis test, including mean, variance,  $\chi^2$  test on contingency tables and goodness-of-fit and likelihood ratio test;
- Linear regression, least square estimation, t-test and F-test, prediction and analysis of residuals;
- Analysis of variance.

Through the teaching process, on the one hand, students are required to understand the basic principles of statistics and master the basic ideas of statistics. On the other hand, students should develop habits of thinking and use statistical knowledge to “discover problems, analyze problems, and solve problems” to improve students’ professional application skills.

### 4. Course Content and Teaching Arrangements

Num	Content	Hours	Type
1	<b>Chap 1:</b> Sampling distributions <ul style="list-style-type: none"> <li>● Concept of random sampling;</li> <li>● Concept of statistical inference;</li> <li>● Normal, t, F and <math>\chi^2</math> distribution.</li> </ul>	6	Lecture, discussion
2	<b>Chap 2:</b> Point estimation <ul style="list-style-type: none"> <li>● Moment matching;</li> <li>● Percentile matching;</li> <li>● Maximum likelihood method, Fisher information matrix, Cramér-Rao lower bound</li> <li>● Properties of an estimator: bias, variance, MSE, consistency, efficiency, and UMVUE.</li> </ul>	12	Lecture, discussion, online quiz
3	<b>Chap 3:</b> Confidence Interval <ul style="list-style-type: none"> <li>● Mean from one normal population;</li> </ul>	7	Lecture, online quiz

	<ul style="list-style-type: none"> <li>● Differences of two means;</li> <li>● Variances from one normal population;</li> <li>● Variance proportions.</li> </ul>		
4	<p><b>Chap 4: Hypothesis test</b></p> <ul style="list-style-type: none"> <li>● Basic problems of hypothesis test;</li> <li>● Neyman-Pearson lemma, significance and power, and information criteria;</li> <li>● Test on mean and variance;</li> <li>● <math>\chi^2</math> test on contingency tables and goodness-of-fit;</li> <li>● Likelihood ratio test.</li> </ul>	6	Lecture, discussion, online quiz
5	<p><b>Chap 5: ANOVA</b></p> <ul style="list-style-type: none"> <li>● Introduction to ANOVA;</li> <li>● One-way ANOVA;</li> <li>● Two-way ANOVA.</li> </ul>	7	Lecture, online quiz
6	<p><b>Chap 6: Univariate linear regression</b></p> <ul style="list-style-type: none"> <li>● Least square estimator;</li> <li>● T-test and F-test;</li> <li>● Prediction using linear regression;</li> <li>● Analysis of residuals</li> </ul>	10	Lecture, discussion, online quiz

## 5. Course Assessment

The course assessment consists of two main parts, one part is quiz and homework, accounting for 30%. The other part is a closed-book examination, which assesses students' knowledge mastery and accounts for 70% of the total.