MI2022 **PROBABILITY AND STATISTICS**

Version: 2024.1.0

1. GENERAL INFORMATION

Course ID:	**MI2022**			
Credits:	**3**			
Workload:	*Theory:* 30 hrs	*Exercise*: 30 hrs	*Practice:* 0 hrs	*Self-study:* 90 hrs
Prerequisites:	Calculus 1, Calculus 2, Algebra			
Co-requisites:	None			
Program				
Level	Second-year students			
Level of using English in teaching	Materials, lecture slides, and assignments in English; Examination in English; Lectures in English.			

2. COURSE DESCRIPTION

The course provides students with the knowledge of probability such as concepts and inference rules for probability as well as random variables and common probability distributions (one-dimensional and two-dimensional); basic concepts of mathematical statistics which help students in dealing with statistical problems in estimation, hypothesis testing, simple linear regression, and correlation. Through the acquired knowledge, students are given a methodology for approaching practical models and finding an appropriate solution.

3. COURSE LEARNING OUTCOMES

Learning Outcomes (LO)	Descriptions	Program Learning Outcomes
M1	**Understand and be able to solve statistics and probability problems**	
M1.1	Recognize principal notions and rules of probability, conditional probability, and independent events. Apply the total probability formula and Bayes' rule.	[1.1-1.4]
M1.2	Identify discrete and continuous random variables, and their probability distributions (probability mass functions, cumulative distribution functions, and probability density functions).	[2.1; 2.2]
M1.3	Identify uniform, binomial, Poisson distributions, and exponential distributions. Determine the critical values for well-known distributions: normal distribution, chi-squared distribution, t-distribution, and F-distribution.	[2.4]
M1.4	Compute the characteristics: mean, variance, covariance, and correlation coefficient. Determine marginal distributions. Recognize independence.	[2.3; 3.1-3.5]
M1.5	Identify the important role of random samples, and their	[3.6; 4.1; 4.2]

Learning Outcomes (LO)	Descriptions	Program Learning Outcomes
	characteristics (sample mean, sample variance), particularly of a normal sample. Apply the Central Limit Theorem and Laws of Large Numbers.	
M1.6	Estimate parameters using point estimators and confidence intervals.	[4.3; 4.4]
M1.7	Test statistical hypotheses, and explain the probability of type I and type II errors.	[5.1-5.3]
M2	**Apply statistics and probability knowledge to modeling and analysis**	
M2.1	Understand and apply statistics and probability to analysis and create some models in real problems	[1.1-1.4; 2.1-2.4; 3.1-3.5; 4.1-4.4; 5.1-5.3]
M2.2	Recognize simple statistical models and apply them to solve economic and engineering problems	[4.1-4.4; 5.1-5.4]
M2.3	Understand and apply to reading specialized materials	[1.1-1.4; 2.1-2.4; 3.1-3.5; 4.1-4.4; 5.1-5.3]
M3	**Capacity to synthesize and present a statistics and probability problem as well as understanding responsibility and professional ethics**	
M3.1	Capacity to work in groups, write reports and present presentations on the results of homework	[1.1-1.4; 2.1-2.4; 3.1-3.5; 4.1-4.4; 5.1-5.3]
M3.2	Understanding responsibilities, professional ethics	

4. CONTENTS

Random events and probability formulas, random variables (one-dimensional and two-dimensional), probability distributions, statistical estimation theory and statistical decision theory.

5. TEXTBOOK AND REFERENCES

Textbooks

[1] R.E. Walpole, R.H. Myers, S.L. Myers, K. Ye (2011). *Probability & Statistics for Engineers and Scientists.* Prentice-Hall (ninth edition).

[2] Gerald Keller (2022). *Statistics for Management and Economics*. South-Western, a part of Cengage Learning (twelfth edition)

References

Vietnamese References

[1] Faculty of Mathematics and Informatics (2024). *Workbook*. Instituted Materials.

[2] Tong Dinh Quy (2009). *Course of Probability and Statistics*. Bach Khoa Publication.

English References

[3] R.A. Johnson (2005). *Probability & Statistics for Engineers*. Person Education, Inc., 2005.

[4] R.E. Walpole, R.H. Myers, S.L. Myers, K. Ye (2011). *Probability & Statistics for Engineers and Scientists.* Prentice-Hall (ninth edition).

[5] W. Feller (1971). *An introduction to Probability theory and its applications*. John Wiley & Sons Publisher.

6. EVALUATIONS

The overall grade of the course is evaluated throughout the learning process, including three main points: the attendance score (20%), the midterm test score (30%), and the final exam score (50%).

Assessment Component	Criteria	Assessment Forms	Course Learning Outcomes	Weight
A1. Process Score				**50%**
A1.1. Attendance Score	Student attitude and diligence	Student diligence	**M1, M2, M3**	20%
A1.2. Midterm Test Score (*)	**A1.2.1. Midterm Test 1** (MTS1, 15 core scale; Content: From week 1 to week 5)	Multiple choice questions ; Fill in the blanks with correct answers	M1.1-M1.2, M2.1	30%
	A1.2.2. Midterm Test 2 (MTS2, 15 core scale; Content: From week 6 to week 10)		M1.2-M1.4, M2.1	
A2. Final Exam Score	Final Exam	Writing	M1, M2.1	**50%**

(*) *The midterm test score* (MTS) *is calculated according to the formula* MTS = 1/3 (MTS1 + MTS2) *and will be adjusted by adding active learning points. Active learning points are worth from –1 to +1, according to the Higher Education Regulations of Hanoi University of Science and Technology.*

7. TEACHING PLAN

Week	Topics	LO	Teaching & Learning Activities	Assessment
[1]	**[2]**	**[3]**	**[4]**	**[5]**
1-2	**Chapter 1:** Random Events and Probability Calculation **1.1.** Basic Notions 1.1.1. Events and Sample Space 1.1.2. Events relation (Union, Intersection, Mutually Exclusive Events, Complement, Mutually exclusive and exhaustive events) 1.1.3. Methods of Counting (Multiplication Rule, Permutation, Combination, Repeated permutation) **Problems - Chapter 1**	M1.1 M2.1 M2.3 M3.1 M3.2	**Teacher:** - Giving lectures - Providing lecture notes, assignments - Leading discussions **Student in class**: - Participating in class activities - Answering questions **Student at home**: - Reading documents - Do homework	A1.1 A1.2.1 A2

Week	Topics	LO	Teaching & Learning Activities	Assessment
[1]	[2]	[3]	[4]	[5]
3-4	**1.2.** Probability 1.2.1. Theoretical Probability Definition 1.2.2. Frequentist Definition **1.3.** Additive and the Multiplicative Rules 1.3.1. Conditional Probability 1.3.2. Additive Rules 1.3.3. The Multiplicative Rules 1.3.4. Bernoulli Trial Calculator **1.4.** Bayes' Theorem 1.4.1. Law of Total Probability 1.4.2. Bayes' Rule **Problems - Chapter 1**	M1.1 M2.1 M2.3 M3.1 M3.2	**Teacher:** - Giving lectures - Providing lecture notes, assignments - Leading discussions **Student in class**: - Participating in class activities - Answering questions **Student at home**: - Reading documents - Do homework	A1.1 A1.2.1 A2
5	**Chapter 2.** Random Variables and Probability Distributions **2.1. Random Variables** 2.1.1 Discrete Random Variables 2.1.2 Continuous Random Variables **2.2. Probability Distributions** 2.2.1. Probability Mass Functions 2.2.2. Cumulative Distribution Functions 2.2.3. Probability Density Functions **Problems - Chapter 2**	M1.2 M2.1 M2.3 M3.1 M3.2	**Teacher:** - Giving lectures - Providing lecture notes, assignments - Leading discussions **Student in class**: - Participating in class activities - Answering questions **Student at home**: - Reading documents Do homework	A1.1 A1.2.1 A2
6	**2.3.** Mathematical Expectations 2.3.1. Expectation 2.3.2. Variance and Standard Deviation **Problems - Chapter 2**	M1.4 M2.1 M2.3 M3.1 M3.2		A1.1 A1.2.2 A2
7	**2.4.** Important Probability Distributions 2.4.1. Uniform Distribution 2.4.2. Binomial Distribution 2.4.3. Poisson Distribution **Problems - Chapter 2**	M1.3 M2.1 M2.3 M3.1 M3.2		A1.1 A1.2.2 A2
8	2.4.4. Exponential Distribution 2.4.5. Normal Distribution 2.4.6. Chi-Square Distribution 2.4.7. t-Distribution **Problems - Chapter 2**	M1.3 M2.1 M2.3 M3.1 M3.2		A1.1 A1.2.2 A2

Week	Topics	LO	Teaching & Learning Activities	Assessment
[1]	[2]	[3]	[4]	[5]
9	**Chapter 3.** Pairs of Random Variables **3.1.** Joint Probability Distributions 3.1.1. The Discrete Case 3.1.2. The Continuous Case **3.2.** Marginal Probability Distributions 3.2.1. The Discrete Case 3.2.2. The Continuous Case **3.3.** Conditional Probability Distributions 3.3.1. The Discrete Case 3.3.2. The Continuous Case **Problems - Chapter 3**	M1.2 M1.4 M2.1 M2.3 M3.1 M3.2	**Teacher:** - Giving lectures - Providing lecture notes, assignments - Leading discussions **Student in class**: - Participating in class activities - Answering questions **Student at home**: - Reading documents - Do homework	A1.1 A1.2.2 A2
10	**3.4.** Independence **3.4.** Functions of Two Random Variables **3.5.** Covariance and Correlation 3.5.1. Covariance. Covariance Matrix 3.5.2. Correlation Coefficient **Problems - Chapter 3**	M1.4 M1.5 M2.1 M2.3 M3.1 M3.2		A1.1 A1.2.2 A2
11	**Chapter 4.** Sampling Distributions and Estimation of Parameters **4.1.** Random Samples 4.1.1. Population and Samples 4.1.2. Sample Mean 4.1.3. Sample Variance and Sample Standard Deviation 4.1.4. Sample Proportions **4.2.** Sampling Distributions 4.2.1. Sampling Distribution of the Sample Mean and Central Limits Theorem 4.2.2. Sampling Distribution of the Sample Variance 4.2.3. Sampling Distribution of Sample Proportions **4.3.** Estimation 4.3.1. Classical Methods of Estimation 4.3.2. Properties of Point Estimators **Problems - Chapter 4**	M1.5 M2.1 M2.2 M2.3 M3.1 M3.2	**Teacher:** - Giving lectures - Providing lecture notes, assignments - Leading discussions **Student in class**: - Participating in class activities - Answering questions **Student at home**: - Reading documents - Do homework	A1 A2
	An Introduction to Statistical Modelling			

Week	Topics	LO	Teaching & Learning Activities	Assessment
[1]	[2]	[3]	[4]	[5]
12	**4.4.** Confidence Interval 4.4.1. Interval Estimation 4.4.2. Confidence Interval on the Mean of a Normal Distribution, Variance Known 4.4.3. Confidence Interval on the Mean of a Normal Distribution, Variance Unknown 4.4.4. Confidence Interval on the Variance and Standard Deviation of a Normal Distribution **Problems - Chapter 4**	M1.6 M2.1 M2.2 M3.1 M3.2	**Teacher:** - Giving lectures - Providing lecture notes, assignments - Leading discussions **Student in class**: - Participating in class activities - Answering questions **Student at home**: - Reading documents - Do homework	A1 A2
13	4.4.5. Large-Sample Confidence Interval for a Population Proportion **Chapter 5.** Hypothesis Testing **5.1.** Introduction to Hypothesis Testing 5.1.1. Statistical Hypotheses 5.1.2. Tests of Statistical Hypotheses **5.2.** Tests of Hypotheses for a Single Sample 5.2.1. Tests on the Mean of a Normal Distribution, Variance Known	M1.6 M1.7 M2.1 M2.2 M3.1 M3.2		A1 A2
14	5.2.2. Tests on the Mean of a Normal Distribution, Variance Unknown 5.2.3. Large-Sample Test 5.2.4. Tests on the Variance and Standard Deviation of a Normal Distribution 5.2.5. Tests on a Population Proportion (Large Sample) **Problems - Chapter 5**	M1.7 M2.1 M2.2 M3.1 M3.2		A1 A2
15	**5.3.** Tests of Hypotheses for Two-Sample 5.3.1. Hypothesis Tests on the Difference in Means, Variances Known 5.3.2. Hypothesis Tests on the Difference in Means, Variances Unknown (Large-Sample and Small-Sample) 5.3.3. Hypothesis Tests on the Ratio of Two Variances 5.3.4. Large-Sample Tests on the Difference in Population Proportions **Problems - Chapter 5**	M1.7 M2.1 M2.2 M3.1 M3.2	**Teacher:** - Giving lectures - Providing lecture notes, assignments - Leading discussions **Student in class**: - Participating in class activities - Answering questions **Student at home**: - Reading documents - Do homework	A1 A2
	An Introduction to Statistical Modelling			

Week	Topics	LO	Teaching & Learning Activities	Assessment
[1]	**[2]**	**[3]**	**[4]**	**[5]**
16	**Review**			

8. COURSE POLICIES

- Students are expected to follow the regulations of Hanoi University of Technology.
- For any cheating during the exam or exercise, students must be disciplined by the school and get 0 points for the course.

9. DATE OF APPROVAL:

Faculty of Mathematics and Informatics