

MI2026**PROBABILITY AND STATISTICS****Version: 2023.1.0**

Objective: The course provides students with the knowledge of probability such as concepts and inference rules of 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, and linear regression. Through the acquired knowledge, students are given a methodology for approaching practical models and finding out an appropriate solution.

Contents: Random events and probability calculation, random variables, probability distributions, random vectors, statistical estimation theory, statistical decision theory, correlation and regression.

1. GENERAL INFORMATION

Course name:	Probability and Statistics
	School of Applied Mathematics and Informatics
Course ID:	MI2026
Course units:	4(3-2-0-8)
	- Lectures: 45 hours
	- Tutorial: 30 hours
Expected participants:	Third-year students in Undergraduate Advanced Programs
Requisites (Prerequisites)	
Requisites (Corequisites):	- MI1111 or MI1112 or MI1113 (Calculus 1)
	- MI1121 or MI1122 (Calculus 2)
	- MI1141 or MI1142 (Algebra)

2. COURSE DESCRIPTION

The purpose of this course is to acquire basic knowledge of probability theory and statistics as a means to describe and analyze information systems and networks that contain randomness, and to build a foundation that can be used in the graduation thesis, etc. In this course, we will learn the fundamentals of descriptive and inference statistics and acquire the basis of probability theory such as random variables and probability distribution.

3. GOALS AND OUTCOMES

At the end of the course, the students should be able to

Goals/OS	Goals description/OS	Output Standard/Level (I/T/U)
[1]	[2]	[3]
M1	Understand and be able to do probability problems	
M1.1	Identify the role of Statistics in the analysis of data from engineering and science. Present graphical and numerical methods for exploring, summarizing and describing data.	ITU
M1.2	Capture principal notions and rules of probability, conditional probability, independent events. Apply the total	ITU

Goals/OS	Goals description/OS	Output Standard/Level (I/T/U)
	probability formula and Bayes' rule.	
M1.3	Identify discrete and continuous random variables, their probability distribution (mass probability function and density probability function).	ITU
M1.4	Determine the critical values for well-known distributions: normal distribution, chi-squared distribution, Student t-distribution, and F-distribution	ITU
M1.5	Compute the characteristics: mean, variance, covariance, correlation coefficient. Determine marginal distributions. Recognize the independence.	TU
M1.6	Identify the important role of random samples, their characteristics (sample mean, sample variance,...), particular of a normal sample. Apply the Central Limit Theorem (CLT) and Laws of Large Numbers (LLN).	ITU
M1.7	Estimate parameters and characteristics using point estimators and confidence intervals.	TU
M1.8	Test statistical hypotheses, explain the probability of type I and type II errors.	ITU
M2	Apply probability knowledge to modeling and analysis	
M2.1	Understand and apply probability to analysis and create some models in real problems	ITU
M2.2	Understand and apply to reading specialized materials	I
M2.3	Recognize simple statistical models and applied them to solve engineering problems	IU
M3	Capacity to synthesize and present a statistics and probability problem as well as understanding responsibility and professional ethics	ITU
M3.1	Capacity to work in groups, write reports and present presentations on the results of homework	TU
M3.2	Understanding responsibilities, professional ethics	IU

I: Introduce; T: Teach; U: Utilize.

4. COURSE MATERIALS

Textbook

- [1] R.E. Walpole, R.H. Myers, S.L. Myers, K. Ye (2011). *Probability & Statistics for Engineers and Scientists*. Prentice-Hall (ninth edition).
- [2] Applied Mathematics Department (2020). *Workbook*. Instituted Materials.

References

- [1] Richard, A. Johnson (2005). *Probability & Statistics for Engineers*, Person Education, Inc., 2005.

- [2] J.S. Milton, J.C. Arnold (2003), *Introduction to Probability and Statistics (Principles and Applications for Engineering and the Computing Sciences)*. McGraw Hill.
- [3] J.L. Devore (2000). *Probability and Statistics for Engineering and the Sciences*. Duxbury.

5. GRADING

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. Attendance Score	Student attitude and diligence	Student diligence	M1, M2, M3	20%
A2. Midterm Test Score (*)	A2.1. Midterm Test 1 (MTS1, 15 core scale; Content: From week 1 to week 5)	Multiple choice questions	M1.1-M1.3, M2.1	30%
	A2.2. Midterm Test 2 (MTS2, 15 core scale; Content: From week 6 to week 10)		M1.3-M1.5, M2.1	
A3. 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.

6. COURSE TOPICS AND SCHEDULE

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
1st	Chapter 1. Descriptive Statistics 1.1. Statistics and Engineering 1.2. Population, Sample 1.3. Pictorial and Tabular Methods 1.3.1. Stem-and-Leaf Displays 1.3.2. Histogram 1.4. Measures of Location 1.4.1. The Mean 1.4.2. The Median 1.4.3. Lower Quartile and Upper Quartile 1.4.4. Inter-Quartile Range 1.5. Measure of Variability 1.5.1. Sample Variance 1.5.2. Sample Standard Deviation 1.5.3. Sample Range	M1.1 M2.1 M2.2 M2.3 M3.1 M3.2	Teacher: - Giving lectures - Providing lecture notes, assignments - Leading discussions Student in class: - Participating class activities - Answering questions Student at home:	A1 A2.1 A3

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	Problems for Chapter 1		- Reading documents - Do homework	
2 nd	Chapter 2. Probability 2.1. Sample Space 2.2. Random Events 2.2.1. Complement 2.2.2. Union 2.2.3. Intersection 2.2.4. Mutually Exclusive Events 2.2.5. Mutually Exclusive and Exhaustive Events 2.3. Counting Outcomes 2.3.1. Multiplication Rule 2.3.2. Permutation 2.3.3. Combination 2.3.4. Newton's Formula 2.3.5. Repeated Permutation	M1.2 M2.1 M2.2 M3.1 M3.2	Teacher: - Giving lectures - Providing lecture notes, assignments - Leading discussions Student in class: - Participating class activities - Answering questions Student at home:	A1 A2.1 A3
3 rd	2.4. Probability of Events 2.4.1. Definition of Probability 2.4.2. Probability of the Complementary Events 2.4.3. Probability of the Union of Events – Addition Rule 2.4.4. Classical Probability 2.5. Conditional Probability 2.5.1. Definition of Conditional Probability 2.5.2. Multiplication Rules 2.5.3. Probability Tree Problems for Chapter 2	M1.2 M2.1 M2.2 M3.1 M3.2	- Reading documents - Do homework	A1 A2.1 A3
4 th	2.6. Independence 2.6.1. Definition 2.6.2. Properties 2.7. The Total Probability Theorem 2.8. Bayes' Rule Problems for Chapter 2	M1.2 M2.1 M2.2 M3.1 M3.2		A1 A2.1 A3
5 th	Chapter 3. Random Variables and Probability Distributions 3.1. Notions of Random Variables 3.1.1. Discrete Random Variables 3.1.2. Continuous Random Variables	M1.3 M2.1 M2.2 M3.1 M3.2	Teacher: - Giving lectures - Providing lecture notes,	A1 A2.1 A3

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	<p>3.2. Cumulative Distribution Function</p> <p>3.3. Expectation or Mean</p> <p>3.3.1. Formula for Discrete Random Variables</p> <p>3.3.2. Formula for Continuous Random Variables</p> <p>3.3.3. Properties</p> <p>3.4. Variance</p> <p>3.4.1. Formula for Discrete Random Variables</p> <p>3.4.2. Formula for Continuous Random Variables</p> <p>3.4.3. Properties</p> <p>Problems for Chapter 3</p>		<p>assignments</p> <p>- Leading discussions</p> <p>Student in class:</p> <p>- Participating class activities</p> <p>- Answering questions</p> <p>Student at home:</p> <p>- Reading documents</p> <p>- Do homework</p>	
6 th	<p>Chapter 4. Random Vectors</p> <p>4.1. Vector of Discrete Random Variables</p> <p>4.1.1. The Marginal Distributions</p> <p>4.1.2. How to Calculate Probabilities</p> <p>4.2. Vector of Continuous Random Variables</p> <p>4.2.1. The Marginal Distributions</p> <p>4.2.2. How to Calculate Probabilities</p> <p>4.3. Independence</p> <p>4.3.1. Definitions</p> <p>4.3.2. Properties</p> <p>4.4. Covariance</p> <p>4.4.1. Covariance Matrix</p> <p>4.4.2. Properties</p> <p>4.5. Correlation Coefficient</p> <p>4.5.1. Definitions</p> <p>4.5.2. Properties</p> <p>4.6. Conditional Distribution</p> <p>4.6.1. Formula for Discrete Random Variables</p> <p>4.6.2. Formula for Continuous Random Variables</p> <p>4.6.3. Properties</p> <p>Problems for Chapter 4</p>	<p>M1.5</p> <p>M2.1</p> <p>M2.2</p> <p>M3.1</p> <p>M3.2</p>	<p>Teacher:</p> <p>- Giving lectures</p> <p>- Providing lecture notes, assignments</p> <p>- Leading discussions</p> <p>Student in class:</p> <p>- Participating class activities</p> <p>- Answering questions</p> <p>Student at home:</p> <p>- Reading documents</p> <p>- Do homework</p>	<p>A1</p> <p>A2.2</p> <p>A3</p>
7 th	<p>Chapter 5. Several Discrete Distributions</p> <p>5.1. Uniform Distribution</p> <p>5.1.1. Definition</p>	<p>M1.4</p> <p>M2.1</p> <p>M2.2</p> <p>M3.1</p>	<p>Teacher:</p> <p>- Giving lectures</p> <p>- Providing</p>	<p>A1</p> <p>A2.2</p> <p>A3</p>

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	5.1.2. Mean and Variance 5.2. Hyper-Geometric Distribution 5.2.1. Definition 5.2.2. Mean and Variance 5.3. Binomial Distribution 5.3.1. Sequence of Bernoulli Trials 5.3.2. Binomial Distribution $B(n, p)$ 5.3.3. Mean and Variance 5.4. Poisson Distribution 5.4.1. Definition 5.4.2. Mean and Variance 5.4.3. Poisson Process Problems for Chapter 5	M3.2	lecture notes, assignments - Leading discussions Student in class: - Participating class activities - Answering questions Student at home: - Reading documents - Do homework	
8 th	Chapter 6. Several Continuous Random Variables 6.1. Uniform Distribution on $[a, b]$, $U(a, b)$ 6.1.1. Definition 6.1.2. Mean and Variance 6.1.3. $U(0, 1)$ 6.2. Exponential Distribution 6.2.1. Definition 6.2.2. Mean and Variance 6.2.3. Poisson Process (continued) 6.3. Gamma Distribution 6.3.1. Definition 6.3.2. Properties 6.3.3. Mean and Variance 6.4. Normal Distribution 6.4.1. Definition 6.4.2. Properties 6.4.3. Mean and Variance 6.4.4. The Standard Normal Distribution 6.4.5. Cumulative Distribution Function of the Standard Normal Distribution 6.4.6. Critical Values 6.4.7. Central Limit Theorem 6.4.8. Normal Approximation for the Binomial Distribution 6.5. Chi-Squared Distribution with (ν)	M1.4 M2.1 M2.2 M3.1 M3.2	Teacher: - Giving lectures - Providing lecture notes, assignments - Leading discussions Student in class: - Participating class activities - Answering questions Student at home: - Reading documents - Do homework	A1 A2.2 A3

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	Degrees of Freedom $\chi^2(v)$ 6.5.1. Definition 6.5.2. Properties 6.5.3. Mean and Variance 6.5.4. Critical Values 6.6. Student Distribution with (v) Degrees of Freedom t(v) 6.6.1. Definition 6.6.2. Properties 6.6.3. Mean and Variance 6.6.4. Critical Values Problems for Chapter 6			
9 th	Chapter 7. Random sample 7.1. Notions 7.1.1. Random Sample 7.1.2. Statistic 7.2. Sample Mean 7.2.2. Definition 7.2.3. Mean and Variance 7.2.4. Central Limit Theorem 7.2.5. Laws of Large Numbers 7.3. Sample Variance 7.3.1. Definition 7.3.2. Mean 7.3.3. Convergence Properties 7.4. Sample from Normal Distribution 7.4.1. Definition 7.4.2. Mean and Variance 7.4.3. Properties Problems for Chapter 7	M1.5 M1.6 M2.1 M2.2 M3.1 M3.2	Teacher: - Giving lectures - Providing lecture notes, assignments - Leading discussions Student in class: - Participating class activities - Answering questions Student at home: - Reading documents - Do homework	A1 A2.2 A3
10 th	Chapter 8. Estimating – Point Estimation 8.1. Problems 8.1.1. Point Estimators 8.1.2. Unbiased Estimator 8.1.3. Consistent Estimator 8.2. Estimating the Population Mean 8.3. Estimating the Population Variance 8.4. Estimating a Proportion or Probability Problems for Chapter 8	M1.7 M2.1 M2.2 M2.3 M3.1 M3.2	Teacher: - Giving lectures - Providing lecture notes, assignments - Leading discussions Student in class: - Participating class activities	A1 A2.2 A3

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
			- Answering questions Student at home: - Reading documents - Do homework	
11 th	<p>Chapter 9. Confidence Intervals</p> <p>9.1. Introduction</p> <p>9.2. Confidence Intervals for the Mean of the Normal Distribution</p> <p>9.3. Confidence Intervals for the Mean of any Distribution, Large Sample</p> <p>9.4. Confidence Intervals for a Proportion or Probability</p> <p>9.5. Confidence Intervals for the Variance of the Normal Distribution</p> <hr/> <p>Problems for Chapter 9</p>	M1.7 M2.1 M2.2 M2.3 M3.1 M3.2	<p>Teacher:</p> <p>- Giving lectures</p> <p>- Providing lecture notes, assignments</p> <p>- Leading discussions</p> <p>Student in class:</p> <p>- Participating class activities</p> <p>- Answering questions</p> <p>Student at home:</p> <p>- Reading documents</p> <p>- Do homework</p>	A1 A2 A3
12 th	<p>Chapter 10. Testing Statistical Hypotheses</p> <p>10.1. Introduction</p> <p>10.1.1. Hypotheses and Tests</p> <p>10.1.2. Errors of Types 1 and 2</p> <p>10.1.3. Critical Region</p> <p>10.2. Test about the Normal Mean when the Variance is Known</p> <p>10.3. Test about the Normal Mean when the Variance is Unknown</p> <p>10.4. Test about the Mean of any Distribution, Large Sample</p> <hr/> <p>Problems for Chapter 10</p>	M1.8 M2.1 M2.2 M2.3 M3.1 M3.2	<p>Teacher:</p> <p>- Giving lectures</p> <p>- Providing lecture notes, assignments</p> <p>- Leading discussions</p> <p>Student in class:</p> <p>- Participating class activities</p> <p>- Answering questions</p>	A1 A2 A3
13 th	<p>10.5. Test about a Proportion or Probability</p> <p>10.6. Test about the Variance of the Normal Distribution</p>	M1.8 M2.1 M2.2 M2.3	<p>Student at home:</p> <p>- Reading</p>	A1 A2 A3

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	<p>10.7. Test about the Difference between two Normal Means</p> <p>10.8. Test about the Difference between two Proportions</p> <p>10.9. Test about the Difference between two Normal Variances</p> <p>Problems for Chapter 10</p>	M3.1 M3.2	documents - Do homework	
14 th	<p>Chapter 11. Regression Analysis</p> <p>11.1. Simple Linear Regression Model</p> <p>11.2. Estimating the Model Parameters</p> <p>11.2.1. Principle of Least Squares</p> <p>11.2.2. Errors</p> <p>11.2.3. Estimating Variance</p> <p>11.2.4. Coefficient of Determination</p> <p>11.2.5. Confidence Intervals for Parameters</p> <p>11.2.6. Analysis of Variance</p> <p>Problems for Chapter 11</p>	M1.7 M2.1 M2.2 M2.3 M3.1 M3.2	<p>Teacher:</p> <p>- Giving lectures</p> <p>- Providing lecture notes, assignments</p> <p>- Leading discussions</p> <p>Student in class:</p> <p>- Participating class activities</p>	A1 A2 A3
15 th	<p>11.3. Regression with Transformed Variables</p> <p>11.4. Multiple Linear Regression Analysis</p> <p>Problems for Chapter 11</p>	M1.7 M2.1 M2.2 M2.3 M3.1 M3.2	<p>- Answering questions</p> <p>Student at home:</p> <p>- Reading documents</p> <p>- Do homework</p>	A1 A2 A3

7. OTHER REGULATIONS

8. APPROVAL DATE

School of Applied Mathematics and Informatics