

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 deal 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 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 Faculty of 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, and independent events. Apply the total probability formula and Bayes' rule.	ITU
M1.3	Identify discrete and continuous random variables, and their	ITU

Goals/OS	Goals description/OS	Output Standard/Level (I/T/U)
	probability distribution (mass probability function and density probability function).	
M1.4	Determine the critical values for well-known distributions: normal distribution, chi-squared distribution, t-distribution, and F-distribution	ITU
M1.5	Compute the characteristics: mean, variance, covariance, correlation coefficient. Determine marginal distributions. Recognize independence.	TU
M1.6	Identify the important role of random samples, their characteristics (sample mean, sample variance, ...), particularly 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, and explain the probability of type I and 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 apply 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).

References

- [1] Faculty of Mathematics and Informatics (2024). *Workbook*. Instituted Materials.
- [2] Richard, A. Johnson (2005). *Probability & Statistics for Engineers*, Person Education, Inc., 2005.
- [3] J.S. Milton, J.C. Arnold (2003), *Introduction to Probability and Statistics (Principles and Applications for Engineering and the Computing Sciences)*. McGraw Hill.

[4] 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. 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-M1.3, M2.1	30%
	A1.2.2. Midterm Test 2 (MTS2, 15 core scale; Content: From week 6 to week 10)		M1.3-M1.6, 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.

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	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 in class activities - Answering questions Student at home:	A1.1 A1.2.1 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	1.5.1. Sample Variance 1.5.2. Sample Standard Deviation 1.5.3. Sample Range 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 in class activities - Answering questions Student at home: - Reading documents - Do homework	A1.1 A1.2.1 A2
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		A1.1 A1.2.1 A2
4 th	2.6. Independence 2.6.1. Definition 2.6.2. Properties 2.7. The Total Probability Theorem	M1.2 M2.1 M2.2 M3.1		A1.1 A1.2.1 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	2.8. Bayes' Rule	M3.2		
	Problems for Chapter 2			
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 3.2. Cumulative Distribution Function 3.3. Expectation or Mean 3.3.1. Formula for Discrete Random Variables 3.3.2. Formula for Continuous Random Variables 3.3.3. Properties 3.4. Variance 3.4.1. Formula for Discrete Random Variables 3.4.2. Formula for Continuous Random Variables 3.4.3. Properties Problems for Chapter 3	M1.3 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	A1.1 A1.2.1 A2
6 th	Chapter 4. Random Vectors 4.1. Vector of Discrete Random Variables 4.1.1. The Marginal Distributions 4.1.2. How to Calculate Probabilities 4.2. Vector of Continuous Random Variables 4.2.1. The Marginal Distributions 4.2.2. How to Calculate Probabilities 4.3. Independence 4.3.1. Definitions 4.3.2. Properties 4.4. Covariance 4.4.1. Covariance Matrix 4.4.2. Properties 4.5. Correlation Coefficient 4.5.1. Definitions	M1.5 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	A1.1 A1.2.2 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	4.5.2. Properties 4.6. Conditional Distribution 4.6.1. Formula for Discrete Random Variables 4.6.2. Formula for Continuous Random Variables 4.6.3. Properties			
	Problems for Chapter 4			
7 th	Chapter 5. Several Discrete Distributions 5.1. Uniform Distribution 5.1.1. Definition 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	M1.4 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	A1.1 A1.2.2 A2
	Problems for Chapter 5			
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	M1.4 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	A1.1 A1.2.2 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	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 (v) 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		Student at home: - Reading documents - Do homework	
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	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	A1.1 A1.2.2 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	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		in class activities - Answering questions Student at home: - Reading documents - Do homework	
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 in class activities - Answering questions Student at home: - Reading documents - Do homework	A1.1 A1.2.2 A2
11 th	Chapter 9. Confidence Intervals 9.1. Introduction 9.2. Confidence Intervals for the Mean of the Normal Distribution 9.3. Confidence Intervals for the Mean of any Distribution, Large Sample 9.4. Confidence Intervals for a Proportion or Probability 9.5. Confidence Intervals for the Variance of the Normal Distribution Problems for Chapter 9	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 in class activities - Answering questions	A1 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
			Student at home: - Reading documents - Do homework	
12 th	Chapter 10. Testing Statistical Hypotheses 10.1. Introduction 10.1.1. Hypotheses and Tests 10.1.2. Errors of Types 1 and 2 10.1.3. Critical Region 10.2. Test about the Normal Mean when the Variance is Known 10.3. Test about the Normal Mean when the Variance is Unknown 10.4. Test about the Mean of any Distribution, Large Sample Problems for Chapter 10	M1.8 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
13 th	10.5. Test about a Proportion or Probability 10.6. Test about the Variance of the Normal Distribution 10.7. Test about the Difference between two Normal Means 10.8. Test about the Difference between two Proportions 10.9. Test about the Difference between two Normal Variances Problems for Chapter 10	M1.8 M2.1 M2.2 M2.3 M3.1 M3.2	- Reading documents - Do homework	A1 A2
14 th	Chapter 11. Regression Analysis 11.1. Simple Linear Regression Model 11.2. Estimating the Model Parameters 11.2.1. Principle of Least Squares 11.2.2. Errors 11.2.3. Estimating Variance 11.2.4. Coefficient of Determination 11.2.5. Confidence Intervals for Parameters 11.2.6. Analysis of Variance	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 in class	A1 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	Problems for Chapter 11		activities	
15 th	11.3. Regression with Transformed Variables	M1.7	- Answering questions	A1
	11.4. Multiple Linear Regression Analysis	M2.1	Student at home: - Reading documents - Do homework	A2
	Problems for Chapter 11	M2.2		
		M2.3		
		M3.1		
		M3.2		
16 th	Review		Leading discussions	A1 A2

7. OTHER REGULATIONS

- 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.

8. APPROVAL DATE

Faculty of Mathematics and Informatics