MI2036
PROBABILITY STATISTICS AND RANDOM SIGNAL PROCESSES

Version: 2024.1.0

Objective: Providing basic knowledge of probability, random variables (one-dimensional and multi-dimensional) including probability distributions, characteristics of random variables; Hypothesis testing; Estimation of random variables; Stochastic processes; and Random signal processing.

Contents: *Basic concepts of experiments, models, probability, random variables (one-dimensional as well as multi-dimensional), probability distributions, characteristics of random variables; Random vectors; Hypothesis testing; Estimation of random variables; Stochastic processes; Random signal processing.*

1. GENERAL INFORMATION

Course name: *Probability Statistics and Random Signal Processes*

Course ID: MI2036

Course units: 3(3-1-0-6)
- Lectures: 45 hours
- Tutorial: 15 hours

Requisites (Prerequisites)**:** No

Requisites (Corequisites)**:**
- MI1111 or MI1112 or MI1113 (Calculus 1),
- MI1121 or MI1122 (Calculus 2),
- MI1141 or MI1142 (Algebra)

Requisites (Parallel)**:** No

2. COURSE DESCRIPTION

This course covers the following areas of probability, statistics, and random signal processes: experiment, outcomes, sample space, events, axiomatic foundations, probability formulas, random variables, distributions, and densities; transformations and expectations; introduces both discrete and continuous families of distributions; random vectors: joint and marginal distributions; Random vectors; Hypothesis testing; Estimation of a random variable; Stochastic processes; Random signal processing.

3. GOAL 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, statistics, and random signal process problems**	
M1.1	Understand the concepts of experiments, events, operations of events, and probability definitions; understand and do problems involving probability formulas	I/T
M1.2	Understand and do problems involving one-dimensional random variables, probability distributions, one-dimensional random variable characteristics, and some common distributions	I/T
M1.3	Understand the concepts of random vectors, probability distributions, characteristics of random vectors and common	I/T

Goals/OS	Goals description/OS	Output Standard/ Level (I/T/U)
	distributions, limit theorems	
M1.4	Practical applications of the theory developed probability theory, hypothesis testing the foundation of many signal detection techniques	I/T
M1.5	Understanding the basic concepts of stochastic processes introduces several topics related to random signal processing	I
M2	**Apply probability, statistics and random signal processes knowledge to modeling and analysis**	
M2.1	Understand and apply probability, statisticss and random signal processes to analysis and create some models in real problems	I/T/U
M2.2	Understand and apply to reading specialized materials	I

4. COURSE MATERIALS

Textbook

[1] Dr. Roy Yates, David J. Goodman, *Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers*, Wiley Publisher, 2 edition (May 20, 2004).

References

[1] Tong Dinh Quy, *Course of Probability and Statistics*, Bach Khoa Publication, 2009.

[2] William Feller, *An introduction to Probability theory and its applications*, John Wiley & Sons Publisher, 1971.

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, M1.2, M2.1	30%
	A1.2.2. Midterm Test 2 (MTS2, 15 core scale; Content: From week 6 to week 10)		M1.2, M1.3, 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]
1	**Chapter 1. Experiments, Models, and Probabilities** 1.1 Set Theory 1.2 Applying Set Theory to Probability 1.3 Probability Axioms 1.4 Some Consequences of the Axioms	M1.1 M2.1 M2.2	**Lecturers:** - Introduce the course. **Student:** - Understand the basic concepts and exercises.	A1.1 A1.2.1 A2
2	1.5 Conditional Probability 1.6 Independence 1.7 Sequential Experiments and Tree Diagrams	M1.1 M2.1 M2.2	**Lecturer:** - Teach, and exchange questions and answers with students during the lecture process. **Students:** - Understand the basic concepts and apply their knowledge to practice the exercises subjects as well as practice some problems related the course contents.	A1.1 A1.2.1 A2
3	1.8 Counting Methods 1.9 Independent Trials	M1.1 M2.1 M2.2		A1.1 A1.2.1 A2
4	**Chapter 2: Discrete Random Variables** 2.1 Definitions 2.2 Probability Mass Function 2.3 Families of Discrete Random Variables 2.4 Cumulative Distribution Function 2.5 Averages	M1.2 M2.1 M2.2		A1.1 A1.2.1 A2
5	2.6 Functions of a Random Variable 2.7 Expected Value of a Derived Random Variable 2.8 Variance and Standard Deviation 2.9 Conditional Probability Mass Function	M1.2 M2.1 M2.2		A1.1 A1.2.1 A2
6	**Chapter 3: Continuous Random Variables** 3.1 The Cumulative Distribution Function 3.2 Probability Density Function 3.3 Expected Values 3.4 Families of Continuous Random Variables	M1.2 M2.1 M2.2		A1.1 A1.2.2 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
7	3.5 Gaussian Random Variables 3.6 Delta Functions, Mixed Random Variables	M1.2 M2.1 M2.2		A1.1 A1.2.2 A2
8	3.7 Probability Models of Derived Random Variables 3.8 Conditioning a Continuous Random Variable	M1.2 M2.1 M2.2		A1.1 A1.2.2 A2
9	**Chapter 4: Random Vectors** 4.1 Joint Cumulative Distribution Function 4.2 Joint Probability Mass Function 4.3 Marginal Probability Mass Function 4.4 Joint Probability Density Function 4.5 Marginal Probability Density Function 4.6 Functions of Two Random Variables	M1.3 M2.1 M2.2		A1.1 A1.2.2 A2
10	4.7 Expected Values 4.8 Central Limit Theorem 4.9 Applications of the Central Limit Theorem	M1.3 M2.1 M2.2		A1.1 A1.2.2 A2
11	**Chapter 5: Hypothesis Testing** 5.1 Basic concepts of hypothesis testing 5.2 Significance Testing	M1.4 M2.1 M2.2		A1 A2
12	5.3 Binary Hypothesis Testing 5.4 Multiple Hypothesis Test	M1.4 M2.1 M2.2		A1 A2
13	**Chapter 6: Estimation of a Random Variable** 6.1 Optimum Estimation Given Another Random Variable 6.2 Linear Estimation of X Given Y 6.3 MAP and ML Estimation	M1.4 M2.1 M2.2		A1 A2
14	**Chapter 7: Random signal processing** 7.1 Stochastic Processes 7.2 Definitions and Examples 7.3 Types of Stochastic Processes 7.4 Random Variables from Random	M1.5 M2.1 M2.2		A1 A2

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	Processes			
15	7.5 Linear Filtering of a Continuous-Time Stochastic Process 7.6 Linear Filtering of a Random Sequence	M1.5 M2.1 M2.2 M2.3		A1 A2
16	Review			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