MI2022 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 and hypothesis testing. 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.*

1. GENERAL INFORMATION

Course name: Probability and Statistics

School of Applied Mathematics and Informatics

Course ID: MI2022

Course units: 2(2-0-0-4)

- Lectures: 30 hours
- Tutorial: 0 hours

Requisites (Prerequisites**)** None

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 statistics and probability problems**	**ITU**
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 probability formula and Bayes' rule.	TU
M1.3	Identify uniform, binomial, Poisson distributions.	TU

Goals/OS	Goals description/OS	Output Standard/Level (I/T/U)
M1.4	Determine the critical values for well-known distributions: normal distribution, chi-squared distribution and student t-distribution.	ITU
M1.5	Compute the characteristics: mean, variance, covariance, correlation coefficient. Determine marginal distributions. Recognize the independence.	ITU
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 and Laws of Large Numbers.	ITU
M1.7	Estimate parameters and characteristics using point estimators and confidence intervals.	ITU
M1.8	Test statistical hypotheses, explain the probability of type I and type II errors.	ITU
M2	**Apply statistics and probability knowledge to modeling and analysis**	**ITU**
M2.1	Understand and apply statistics and probability to analysis and create some models in real problems	ITU
M2.2	Recognize simple statistical models and applied them to solve engineering problems	IU
M2.3	Understand and apply to reading specialised materials	I
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-M1.2, M2.1	**30%**
	A2.2. Midterm Test 2 (MTS2, 15 core scale; Content: From week 6 to week 10)		M1.2-M1.5, M1.7, M2.1	
A3. Final Exam Score	Final Exam	Writing	**M1**, M2.1, M3.1	**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** What are Statistics and Probability? **1.2** Population and Sample **1.3** Statistics (Descriptive and Inferential) **1.4** Describing Data (Descriptive Statistics) **1.5** Variables and Data **1.6** Graphs for Categorical Data, for Quantitative Data **1.7** Frequency Histograms **1.8** Numerical Statistical Measures (averages, variance, standard deviation) **1.9** Measures of Center (mean or average, median, mode) **1.10** Measures of Variability (range, variance, standard deviation)	M1.1 M2.1 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**: - Reading documents - Do homework	A1 A2.1 A3

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	1.11 Measures of Relative standing (percentiles)			
2nd	**Chapter 2: Probability** **2.1.** Events and Sample Space, Events Relation 2.1.1 Events and Sample space 2.2.2 Events relation (Union, Intersection, Mutually Exclusive, Complement, Exhaustive) **2.2.** Counting Outcomes 2.2.1. Multiplication Rule 2.2.2. Permutation 2.2.3. Combination 2.2.4. Newton's Formula 2.2.5. Repeated Permutation	M1.2 M2.1 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**: - Reading documents - Do homework	A1 A2.1 A3
3rd	**2.3** Definition of Probability 2.3.1. Theoretical Probability Definition 2.3.2. Empirical Probability **2.4** Addition, Multiplication and Bayes Theorems 2.4.1 Addition Rules	M1.2 M2.1 M2.3 M3.1 M3.2		A1 A2.1 A3
4th	2.4.2 Conditional Probability 2.4.3 Multiplicative Rules 2.4.4 Bayes' Rule			
5th	**Chapter 3: Random Variables and Probability Distributions** **3.1** Discrete Distribution: Binomial, Poisson Distributions 3.1.1 Discrete Random Variables and Probability Distribution 3.1.2 Mean and Standard Deviation 3.1.3 Binomial and Poisson Distributions	M1.3 M1.4 M1.5 M2.1 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**: - Reading documents - Do homework	A1 A2.1 A3
6th	**3.2** Continuous Distribution: Normal, Exponential Distributions 3.2.1 Continuous Random Variables and Probability Distribution 3.2.2 Probability Distribution and Probability Density Functions	M1.3 M1.4 M1.5 M2.1 M2.3 M3.1		A1 A2.2 A3

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
7th	3.2.3 Mean and Standard Deviation 3.2.4 Normal and Exponential Probability Distributions	M3.2		
8th	**Chapter 4: Random Vectors** **4.1** Anticipated Value and Bivariate Distribution 4.1.1 Mean and Standard Deviation 4.1.2 Covariance and Correlation Coefficient	M1.3 M1.5 M2.1 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**: - Reading documents - Do homework	A1 A2.2 A3
9th	**4.2** Law of Large Numbers and Central Limits Theorem 4.2.1 Chebyshev's Theorem 4.2.2 Law of Large Numbers 4.2.3 Central Limits Theorem	M1.3 M1.5 M1.6 M2.1 M2.3 M3.1 M3.2		A1 A2.2 A3
10th	**Chapter 5: Estimating – Point Estimation and Confidence Interval** **5.1** Sample and Sampling Distributions 5.1.1 Statistics and Sampling Distributions 5.1.2 Sampling Distribution of Sample Mean, of Sample Proportions 5.1.3 Student's Distribution	M1.1 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 - Answering questions **Student at home**: - Reading documents - Do homework	A1 A2.2 A3
11th	**5.2** Large-Sample Estimation 5.2.1 Point Estimation 5.2.2 Interval Estimation or Confidence Interval (for Population Mean and Proportion)			A1 A2 A3
12th	**Chapter 6. Testing Statistical Hypotheses** **6.1** Large-Sample Tests with One population 6.1.1 Testing Hypothesis about Population Parameters 6.1.2 Large-Sample Tests about Population Mean	M1.1 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 class	A1 A2 A3

Schedule	Contents	OS	Teaching and learning activities	Assessment
[1]	[2]	[3]	[4]	[5]
	6.1.3 Large-Sample Tests about Population Proportion 6.1.4 Large-Sample Tests about Population Variance		activities - Answering questions **Student at home**: - Reading documents - Do homework	
13th	**6.2** Large-Sample Tests with Two population 6.2.1 Large-Sample Tests of Hypothesis for Difference between Two Population Proportion 6.2.2 Large-Sample Tests of Hypothesis for Difference between Two Population Mean	M1.1 M1.8 M2.1 M2.2 M2.3 M3.1 M3.2		A1 A2 A3
14th	**6.3** Inference from Small Samples 6.3.1 Small-Sample Inferences Concerning Population Mean 6.3.2 Small-Sample Inferences Concerning Population Variance Small-Sample Inferences for 6.3.3 Difference between Two Population Mean	M1.1 M1.8 M2.1 M2.2 M2.3 M3.1 M3.2		A1 A2 A3
15th	**Revision**	M1 M2	Leading discussions	A1 A2 A3

7. OTHER REGULATIONS

8. APPROVAL DATE

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