I. CURRICULUM

Program description *(optional)*

SECOND YEAR							
No.	**Code**	**Module**	**ECTS**	**Total teaching hours**	**Lecture Hours**	**Practical hours**	**Tutorial hours**
1	MAT2.006	Computational Linear Algebra	4	40	20		20
2	MAT2.007	Probability	4	40	20		20
3	MAT2.008	Dynamical Systems	3	36	24		12
4	MAT2.009	Graph Theory	4	40	20		20
5	MAT2.010	Optimization 1	3	36	18		18
6	ICT2.001	Algorithms and Data Structures	3	36	20	16	
7	ICT2.003	Object - oriented programming	4	40	30	10	
8	FR2.001	French 2.1	4	60	60	0	
9	MS2.005	Basic Principles of Project Management	2	20	20	0	
10	PHI2.001	Philosophy	0	30	30	0	
11	MAT2.011	Statistics	4	40	20		20
12	MAT2.012	Numerical Analysis	4	40	20		20
13	MAT2.013	Mathematical Modeling	4	40	20		20
14	MAT2.014	Optimization 2	3	36	18		18
15	MAT2.015	Stochastic Processes	3	36	18		18
16	ICT2.010	Image Processing	3	36	27	9	
17	ICT2.013	Advanced programming with Python	4	40	30	10	
18	FR2.002	French 2.2	4	60	60	0	
19	MS2.006	Intellectual Property Management	2	20	18		2
THIRD YEAR							
No.	**Code**	**Module**	**ECTS**	**Total teaching hours**	**Lecture Hours**	**Practical hours**	**Tutorial hours**
1	MAT3.001	Data Assimilation	4	40	20		20

SECOND YEAR							
No.	**Code**	**Module**	**ECTS**	**Total teaching hours**	**Lecture Hours**	**Practical hours**	**Tutorial hours**
2	MAT3.002	Multivariate Statistics	4	40	20		20
3	MAT3.003	Mathematical Finance	4	40	20		20
4	MAT3.004	Machine Learning: Optimization Approach	4	40	20		20
5	MAT3.005	Machine Learning: Statistical Approach	4	40	20		20
6	ICT3.013	Natural Language Processing	3	30	20	7	3
7	ICT3.015	Computer Vision	3	30	20	10	
8	MAT3.006	Group Project	5				
9	FR3.001	French 3.1	4	66	66		0
10	MS3.001	Scientific Writing and Communication	2	20	20		
11	FR3.002	French 3.2	3	34	34		0
12	MS3.002	Startups	2	20	20		0
13	MAT3.007	Internship	20				

II. SECOND YEAR PROGRAM

1. Overview

No.	Code	Module	Lecturers
1	MAT2.006	Computational Linear Algebra	Trần Giang Nam
2	MAT2.007	Probability	Phạm Việt Hùng
3	MAT2.008	Dynamical Systems	Đỗ Hoàng Sơn
4	MAT2.009	Graph Theory	Trần Giang Nam
5	MAT2.010	Optimization 1	Lê Xuân Thanh
6	ICT2.001	Algorithms and Data Structures	Đoàn Nhật Quang
7	ICT2.003	Object - oriented programming	Nghiêm Thị Phương Trần Giang Sơn Kiều Quốc Việt
8	FR2.001	French 2.1	
9	MS2.005	Basic Principles of Project Management	
10	PHI2.001	Philosophy	
11	MAT2.011	Statistics	Hồ Đăng Phúc

12	MAT2.012	Numerical Analysis	Nguyễn Quỳnh Nga
13	MAT2.013	Mathematical Modeling	Đoàn Thái Sơn
14	MAT2.014	Optimization 2	Lê Xuân Thanh
15	MAT2.015	Stochastic Processes	Cấn Văn Hảo
16	ICT2.010	Image Processing	Nghiêm Thị Phương
17	ICT2.013	Advanced programming with Python	Trần Giang Sơn
18	FR2.002	French 2.2	Trần Thị Phương Thảo, Nguyễn Tuấn Anh, Trương Thị Khánh Hoà, Invited lecturer
19	MS2.006	Intellectual Property Management	Lê Thị Thu Hiền

2. Syllabus

MAT2.006 COMPUTATIONAL LINEAR ALGEBRA
COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Computational Linear Algebra		
	Đại số tuyến tính tính toán		
Course Code	MAT2.006	**Credit points (ECTS)**	4
Academic year	2023-2024		
Lecturer	Tran Giang Nam		
Phone	0384461302		
Email	tgnam@math.ac.vn		
Requirement	- Programming (MATLAB)		
Prerequisites	- Calculus I, Calculus II - Linear algebra		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	0 hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	Computational linear algebra
Course learning outcomes (CLO)	Understand the basic knowledge in combining techniques from linear algebra and computer to solve linear algebraic problems.
Briefly describing on course	The course provides a fundamental computational linear algebra approaches to solve many linear algebra problems with computer
References	[1] L.N. Trefethen and David Bau, III. Numerical Linear Algebra. SIAM, Philadelphia, 1997. [2] DJ Higham, NJ Higham, MATLAB Guide. SIAM, Philadelphia, 2005.

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	0%	
Mid-term exam	40%	Writing exam/ Multi-Choice Question
Project / Presentation	0%	
Final exam	50%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Matrix-Vector Multiplication and Orthogonal Vectors and Matrices, Norms	2	2	0	[1, Lecture 1 & Lecture 2]
2	Singular Value Decomposition	2	2	0	[1, Lecture 4]
3	Projectors	2	2	0	[1, Lecture 6]
4	QR Factorization	2	2	0	[1, Lecture 7]
5	Gram-Schmidt Orthogonalization	2	2	0	[1, Lecture 8]
6	MATLAB	2	2	0	[1, Lecture 9]
7	Least Squares Problems	2	2	0	[1, Lecture 11]
8	Systems of Equations: Gaussian Elimination	2	2	0	[1, Lecture 20]
9	Systems of Equations: Pivoting	2	2	0	[1, Lecture 21]
10	Systems of Equations: Cholesky Factorization	2	2	0	[1, Lecture 22]

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*

Practicals mostly refer to Lab- work or outside practice such as field trip

MAT2.007 PROBABILITY

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Probability		
	Xác suất		
Course Code	MAT2.007	**Credit points (ECTS)**	4
Academic year	2023-2024		
Lecturer	Phạm Việt Hùng		
Phone	0981561391		
Email	pvhung@math.ac.vn		
Requirement	- Required		
Prerequisites	- Calculus I, Calculus II		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	0 hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	Probability, limit theory
Course learning outcomes (CLO)	Basic knowledge on the probability theory, the chance, the sum of random vectors.
Briefly describing on course	The course provides a fundamental background on probability theory. This course also provides many practical examples with speciality in Data Science. Other practical examples in Finance, Assurance, ... are also given.
References	[1] Stanley H. Chan, Introduction to Probability for Data Science, *Michigan Publishing*, *2023.* ISBN 978-1-60785-747-1 [2] C.M. Grinstead and J. Laurie Snell. Introduction to Probability. *American Mathematical Society*, 1997. [3] A. Vetier. ProbabilityTheory with Simulations.

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	0%	
Mid-term exam	30%	Writing exam
Project / Presentation	0%	
Final exam	60%	Writing exam

MAIN CONTENTS

C	Contents	Hours	Ref./Resources

		Lect.	Exr.	Prc.	
1	Probability space and events	02	02		[1, Chapter 2]
2	Independence and Bayes formula	02	02		[1, Chapter 2]
3	Discrete random variables	02	02		[1, Chapter 3]
4	Continuous random variables	02	02		[1, Chapter 4]
5	Expectation and Variance	02	02		[1, Chapter 5]
6	Random vectors	02	02		[1, Chapter 5]
7	Law of large numbers	02	02		[2, Chapter 8]
8	Central limit theorem	02	02		[2, Chapter 9]
9	Probability with simuluation: random numbers & Discrete distribution	02	02		[3, Part II]
10	Probability with simuluation: Continuous distribution, Law and central limite theorem	02	02		[3, Part III]

Notes:

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- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

MAT2.008 DYNAMICAL SYSTEMS

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Dynamical Systems		
	Hệ động lực		
Course Code	MAT2.008	**Credit points (ECTS)**	3
Academic year	2023-2024		
Lecturer	Đỗ Hoàng Sơn		
Phone			
Email	dhson@math.ac.vn		
Requirement	- Required		
Prerequisites	- Calculus I, Calculus II - Linear algebra - Basic ordinary differential equations: Solving some fundamental ordinary differential equations, Exact solutions.		
Time Commitment	Lecture	18 hrs	
	Exercises/Tutorial	18 hrs	
	Practical/Labwork	0 hrs	
	Total	36 hrs	

DESCRIPTION

Course Objectives	Dynamical Systems, Ordinary Differential Equations, stability theory, Numerical method
Course learning outcomes (CLO)	Students acquire basic concepts and techniques in Dynamical systems theory as well as some applications
Briefly describing on course	This course introduces students to the theory and applications of dynamical systems in the field of applied mathematics. It covers the fundamental concepts, techniques, and tools for analyzing and modeling dynamic phenomena in various scientific and engineering disciplines.
References	M.W. Hirsh, S. Smale and R. L. Devaney, *Differential Equations, Dynamical Systems, and an Introduction to Chaos,* Academic Press, 2012.

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	10%	
Mid-term exam	30%	Writing exam/ Multi-Choice Question
Project / Presentation	0%	

Final exam	50%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Introduction to Dynamical Systems	02	01		[3, Chapter 1]
2	Planar Linear Systems	02	01		[1, Chapter 2]
3	Phase Portraits for Planar Systems	02	01		[1, Chapter 3]
4	Nonlinear Systems	02	01		[1, Chapter 7]
5	Equilibria in Nonlinear Systems	02	01		[1, Chapter 8]
6	Global Nonlinear Techniques	02	01		[1, Chapter 9]
7	Closed Orbits and Limit Sets	02	01		[1, Chapter 10]
8	Some Applications	02	01		[1, Chapters 11-13]
9	Discrete Dynamical Systems	02	01		[1, Chapter 15]
10	Numerical Methods for Dynamical Systems	02	01		[1, Chapter 7]
11	Dynamics of some special maps	02	01		[2, Chapter 10]
12	Chaos Theory	02	01		[2, Chapter 12]

Notes:

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- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*

Practicals mostly refer to Lab- work or outside practice such as field trip

MAT2.009 GRAPH THEORY

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Graph theory		
	Lý thuyết đồ thị		
Course Code	MAT2.009	**Credit points (ECTS)**	4
Academic year	2023-2024		
Lecturer	Tran Giang Nam		
Phone	0384461302		
Email	tgnam@math.ac.vn		
Requirement	- Programming		
Prerequisites	- Linear algebra - Discrete mathematics		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	0 hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	Graph theory
Course learning outcomes (CLO)	To provide an understanding key concepts of graph theory.
Briefly describing on course	To provide an understanding key concepts of graph theory.
References	[1] G. Chartrand and P. Zhang. *A first course in Graph theory*. Dover books on mathematics, 2012. [2] R. Balakrishnan and K. Ranganathan. *A Textbook of Graph Theory*. Universitext Springer 2012. [3] S. Saha Ray. *Graph Theory with Algorithms and its Applications*. Springer 2013.

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	0%	
Mid-term exam	40%	Writing exam/ Multi-Choice Question
Project / Presentation	0%	
Final exam	50%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Review of introductory graph theory	2	2	0	[1, Chapter 1]
2	Degrees	2	2	0	[1, Chapter 2]
3	Trees	2	2	0	[1, Chapter 4]
4	Connectivity	2	2	0	[1, Chapter 5]
5	Traversability	2	2	0	[1, Chapter 6]
6	Matching and Factorization	2	2	0	[1, Chapter 8]
7	Graph colouring	2	2	0	[1, Chapter 10]
8	Ramsey numbers	2	2	0	[1, Chapter 11]
9	Use of software/algorithms to solve graph-theoretical problems I	2	2	0	[3, Chapter 5]
10	Use of software/algorithms to solve graph-theoretical problems I	2	2	0	[3, Chapter 5]

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*

Practicals mostly refer to Lab- work or outside practice such as field trip

MAT2.010 OPTIMIZATION 1

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	In English: Optimization 1		
	In Vietnamese: Tối ưu 1		
Course Code	*MAT2.010*	**Credit points (ECTS)**	3
Academic year	2024-2025		
Lecturer	Lê Xuân Thanh		
Phone	+84 986815729		
Email	lxthanh@math.ac.vn		
Requirement	Required		
Prerequisites	Linear Algebra, Calculus		
Time Commitment	Lecture:	18 hrs	
	Exercises/Tutorial	18 hrs	
	Practical/Labwork	0 hrs	
	Total	36 hrs	

DESCRIPTION

Course Objectives	CO1	Identify an optimization problem in a real-world context
	CO2	Formulate some simple problems in form of optimization problems
	CO3	Describe and apply / implement a set of basic optimization algorithms
	CO4	Choose and apply an appropriate algorithm to solve basic optimization problems
Course learning outcomes (CLO)	CLO 1: Able to model real-world problems as optimization problems	
	CLO 2: Able to classify optimization models	
	CLO 3: Able to use appropriate optimization to solve modelled problems	
	CLO 4: Able to implement optimization algorithms to solve small-scaled optimization problems	
	CLO 5: Able to use some optimization softwares to solve large-scaled optimization problems	
Briefly describing on course	This course is designed to introduce the basic background in the domain of Optimization. Students will learn how to model a problem in real-world context as an optimization problem and then solve the modelled problem using appropriate algorithms and tools in Optimization.	
References	(1) Steven Boyd and Lieven Vandenberghe. *Convex Optimization.* Cambridge University Press (2004) (2) Urmila Diwekar. Introduction to Applied Optimization. Springer (2008)	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Mid-term exam	30%	Writing exam
Final exam	60%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	**Chapter 1 Introduction** - Basic concepts of Optimization - Classify optimization problems - Some applications in real-world context	2	2	0	Ref. (2)
2	**Chapter 2 Continuous Optimization** - Preliminaries in Analysis and Linear Algebra - Unconstrained Optimization: First- and second- order methods - Constrained Optimization: Level-set and Lagrangian methods	4	4		Ref. (2)
3	**Chapter 3 Convex Optimization** - Preliminaries in Convex Analysis - Formulation and Lagrangian method	4	4		Ref. (1)
4	**Chapter 4 Linear Programming** - Formulations - Structure of feasible sets - Simplex method	8	8		Ref. (2)

ICT2.001 ALGORITHMS AND DATA STRUCTURES
COURSE SYLLABUS

GENERAL INFORMATION

Course Title	In English: Cấu trúc dữ liệu và Giải thuật		
	In Vietnamese: Algorithms and Data Structures		
Course Code	*ICT2.001*	**Credit points (ECTS)**	3
Academic year	B2		
Lecturer	Dr. Doan Nhat Quang		
Phone	0965913622		
Email	doan-nhat.quang@usth.edu.vn		
Requirement	Basic programming, Introduction to Algorithms		
Prerequisites			
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	hrs	
	Practical/Labwork	16 hrs	
	Total	36 hrs	

DESCRIPTION

Course Objectives	CO1	Provide the foundation of computer programming
	CO2	Study a diversity of algorithms in recursion, sorting, and searching.
	CO3	Learn different data structures and their applications in real-life
Course learning outcomes (CLO)	CLO 1: Understand the foundation of computer programming	
	CLO 2: Understand the analysis and design of computer algorithms and data structures.	
	CLO 3: Analyze and solve real-world problems using data structures and algorithms	
	CLO 4: Self-study and improve programming skills	
Briefly describing on course	The course provides the essential concepts and techniques in Computer Algorithms and Data Structures. Topics include algorithm analysis, abstract data types, linear and non-linear data structures, sorting and searching algorithms, and real-world applications.	
References	(3) Adam Drozdek, *Data Structures and Algorithms in C++*, 4th Edition, Cengage Learning, 2012	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	0%	
Mid-term exam	40%	Labwork assignment

Project / Presentation	0%	
Final exam	50%	Coding

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Introduction	2			Chap 1-2
2	Elementary Data Structure	3		2	Chap 1-2
3	Linked Lists	3		2	Chap 3
4	Stacks and Queues	3		2	Chap 4
5	Recursion	3		2	Chap 5
6	Searching and Advanced Sorting	3		2	Chap 9
7	Trees & Graphs	3		2	Chap 6-8
8	Review			4	

Notes:

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- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

Hanoi, dated…….

DIRECTOR DEPARTMENT OF ……

ICT2.003 OBJECT- ORIENTED PROGRAMMING

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	In English: Object oriented programming		
	In Vietnamese: Lập trình hướng đối tượng		
Course Code	ICT2.003	**Credit points (ECTS)**	4
Academic year	2023-2024		
Lecturer	Trần Giang Sơn, Nghiêm Thị Phương, Kiều Quốc Việt, Huỳnh Vinh Nam		
Phone			
Email			
Requirement	- Required		
Prerequisites	Basic programming		
Time Commitment	Lecture	30 hrs	
	Exercises/Tutorial	0 hrs	
	Practical/Labwork	10 hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	CO1	Provide students with essential object-oriented programming concepts, principles, and techniques
	CO2	Practice students how to use these concepts and principles with Java programming language
Course learning outcomes (CLO)	CLO1	Understand the basic principles and concepts of object-oriented programming
	CLO2	Be able to use these concepts and principles with Java programming language
	CLO3	Be able to apply object-oriented techniques to develop computer programs
Briefly describing on course	The course is about fundamental programming methodology for creating computer applications. Object-Oriented Programming offers a wide range of advantages over procedural programming such as easier debugging, easier code reuse, etc. This course introduces fundamental concepts and techniques in object-oriented programming such as classes, objects, encapsulation, inheritance and polymorphism. The concepts will be illustrated using the Java programming language	
References	(4) C. Thomas Wu, An Introduction to Object-Oriented Programming with Java, 5th Edition, McGraw-Hill Education, 2009 (5) Deitel & Deitel, Java How to Program, 9th Edition, Prentice Hall, 2011	

ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	0%	
Mid-term exam	40%	Writing exam/ Programming exam/ Moodle exam
Final exam	60%	Writing exam/ Programming exam/ Moodle exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Course Introduction Introduction to Object-Oriented Programming	3			
2	Introduction to Java Programming Language	3		1	
3	Objects and Classes Instance Variables and Methods Encapsulation and Information Hiding	3		1	
4	Objects and Object References	3		1	
5	Class Members vs. Instance Members Java Packages	3		1	
6	Inheritance and Polymorphism	3		2	
7	Abstract Classes	3		1	
8	Interfaces	3		1	
9	Exceptions	3		1	
10	I/O Streams	3		1	

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions.*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

Hanoi, dated……

DIRECTOR DEPARTMENT OF ……

MAT2.011 STATISTICS

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Statistics		
	Thống kê		
Course Code	MAT2.011	**Credit points (ECTS)**	4
Academic year	2023 - 2014		
Lecturer	**Ho Dang Phuc**		
Phone	0973949628		
Email	hdphuc@math.ac.vn		
Requirement	- Required basic knowledge of statistical data analysis, elementary statistical hypothesis tests, simple linear regression analysis - Elective - Free Elective		
Prerequisites	Elementary knowledge of probability, basic skills of the Excel software		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	CO1	Understand the basic concepts of statistics, statistical data, statistical parameter estimation, descriptive statistics, inferential statistics, simple linear regression model
	CO2	Have the basic knowledge of statistical data analysis, elementary statistical hypothesis tests, simple linear regression analysis method
	CO3	Use the Excel software to implement the statistical data analysis for simple problems
	CO4	Analyse the real-world simple problems of statistical data
Course learning outcomes (CLO)	CLO 1: Implement data in proper manner for statistical analysis	
	CLO 2: Implement descriptive statistical analysis	
	CLO 3: Implement elementary statistical hypothesis tests analysis	
	CLO 4: Implement simple linear regression analysis	
	CLO 5: Represent the elementary statistical data analysis results	
Briefly describing on course	This course is designed to introduce the definitions, theory, analysis methods, and calculation tools in the domain of statistical data analysis. Students will learn how to solve the elementary problems of data analysis using statistical analysis tools.	
References	(6) Kandethody M. Ramachandran and Chris P.Tsokos, *Mathematical Statistics with Applications*, Elsevier Academic Press 2009	

	(7) Frederick J. Gravetter and Larry B. Wallnau, *Statistics for the Behavioral Sciences*, Cengage Learning 2015

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	10%	
Mid-term exam	30%	Writing exam
Project / Presentation	0%	
Final exam	50%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	**Chapter 1 Introduction to Statistics** - Basic concepts of Statistics - Models of statistical sampling - Statistical Data	2	0		
2	**Chapter 2 Descriptive Statistics** - Description of single categorical variables - Description of two categorical variables - Description of single quantitative variables - Description of two quantitative variables - Excel tools for descriptive statistics	4	6		
3	**Chapter 3 Statistical Parameter Estimation** - Basic concepts of statistical parameter estimation - Probability distribution of parameter estimation - Confidence interval of parameter estimation	2	0		
4	**Chapter 4 One-sample Statistical Hypothesis Tests** - One-sample Tests for proportion - One-sample Tests for mean value – known variance - One-sample Tests for mean value – unknown variance - Excel tools for one-sample tests	4	4		
5	**Chapter 5 Two-sample Statistical Hypothesis Tests** - Two- independent samples Tests for proportions - Two- independent samples Tests for mean values - Two- independent samples Tests for variances - Two- related samples Tests for mean values - Excel tools for two-samples tests	4	6		

6	**Chapter 6 Multi-sample Statistical Hypothesis Tests** - Multi- independent samples Tests for proportions - Multi- independent samples Tests for mean values - Excel tools for multi-samples tests	2	2		
7	**Chapter 7 Simple Linear Regression** - Simple linear regression model - Excel tools for analysis of simple linear regression model	2	2		

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ... for each class sessions*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

MAT2.012 NUMERICAL ANALYSIS

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Numerical Analysis		
	Giải tích số		
Course Code	*MAT2.012*	**Credit points (ECTS)**	4
Academic year	2023-2024		
Lecturer	Dr. Nguyen Quynh Nga		
Phone	0975778265		
Email	nqnga@math.ac.vn		
Prerequisites	- Calculus I, Calculus II - Linear algebra - Ordinary differential equations - Algorithms		
Recommended background knowledge	-Programming		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	0 hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	CO1	This course is an introduction to a broad range of numerical methods for solving mathematical problems that arise in Science and Engineering.
	CO2	The goal is to provide a basic understanding of the derivation, analysis, and use of these numerical methods
	CO3	This course will help students choose, develop and apply the appropriate numerical techniques for their problems, interpret the results, and assess accuracy.
Course learning outcomes (CLO)	CLO 1: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.	
	CLO 2: Apply numerical methods to obtain approximate solutions to mathematical problems	
	CLO 3: Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.	

	CLO 4: Analyse and evaluate the accuracy of common numerical methods.
	CLO 5: Understand the stability of the numerical methods employed.
Briefly describing on course	This course is designed to introduce numerical methods - i.e. techniques which lead to the (approximate) solution of mathematical problems which are usually implemented on computers. The course covers derivation of useful methods and analysis of their accuracy and applicability.
References	(8) S. Saha Ray. *Numerical Analysis with Algorithms and Programming*. CRC Press 2016. (9) L. Ridway Scott. *Numerical Analysis*. Princeton University Press 2011.

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	10%	
Mid-term exam	20%	Writing exam
Project / Presentation	0%	
Final exam	60%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	**Chapter 1 Errors in Numerical Computations** - Introduction - Preliminary Mathematical Theorems - Approximate numbers and significant figures - Rounding off numbers - Truncation errors - Propagation of errors - -General formular for errors - Loss of significance errors - Numerical stability, condition number, and convergence **Chapter 2 Numerical solutions of Algebraic and Transcendental equations** - Introduction - Basic concepts & Definitions	2	2	0	[1, Chapter 1, Section 1.1- 1.5, 1.7-1.10] [1, Chapter 2, Section 2.1-2.2.]
2	- Initial Approximation - Iterative methods	3	3	0	[1, Chapter 2, Section 2.3-2.5,

	- Generalized Newton's Method **Chapter 3 Interpolation** - Introduction				Chapter 3 Section 3.1]
3	- Polynomial interpolation + Geometric Interpretation of Interpolation + Error in Polynomial Interpolation + Finite Differences + Shift, Differentiation, and Averaging Operators + Factorial Polynomial + Backward Differences + Newton's Forward Difference Interpolation + Newton's Backward Difference Interpolation	3	3	0	[1, Chapter 3 Section 3.2 Subsection 3.2.1-3.2.8]
4	- Polynomial interpolation (cont.) + Lagrange's Interpolation Formula + Divided Difference + Gauss's Forward Interpolation Formula + Gauss's Backward Interpolation Formula + Central Difference + Hermite's Interpolation Formula + Piecewise Interpolation + Cubic Spline Interpolation **Chapter 4 Numerical differentiation** - Introduction - Numerical differentiation for equispaced nodes	3	3	0	[1, Chapter 3 Section 3.2 Subsection 3.2.9-3.2.16 Chapter 4 Section 4.1,4.3]
5	- Numerical differentiation for unequally spaced nodes - Richardson extrapolation **Chapter 5 Numerical integration** - Introduction - Numerical Integration from Lagrange's Interpolation - Newton–Cotes Formula for Numerical Integration (Closed Type). - Numerical Integration Formula from Newton's Forward Interpolation Formula - Richardson Extrapolation	3	3	0	[1,Chapter 4 Section 4.4,4.5, Chapter 5, Section 5.1-5.3,5.5-5.6,]

6	- Romberg Integration - Double Integration **Chapter 6 Numerical solutions of ordinary differential equations** - Introduction - Single-step methods +Picard's Method of Successive Approximations +Taylor's Series Method +General Form of a Single-Step Method +Euler Method	3	3	0	[1 Chapter 5, Section 5.7, 5.11, Chapter 7, Section 7.1,7.2, Subsection 7.2.1-7.2.4]
7	- Single-step methods (cont.) +Improved Euler Method +Runger Kutta Methods - Multistep Methods - System of Ordinary Differential Equations of First-Order - Differential Equations of Higher Order	3	3	0	[1 Chapter 7, Section 7.2 Subsection 7.2.5-7.2.6, Section 7.3-7.5]

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

MAT2.013 MATHEMATICAL MODELING

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Mathematical Modeling Mô hình toán học		
Course Code	*MAT2.013*	**Credit points (ECTS)**	4
Academic year	2023 -2024		
Lecturer	Prof. Đoàn Thái Sơn		
Phone			
Email	dtson@math.ac.vn		
Requirement	- Required		
Prerequisites	Calculus I, Calculus II Ordinary differential equations,		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	hrs	
	Total	40hrs	

DESCRIPTION

Course Objectives	CO1	Understand the basic knowledge of…
	CO2	Describe the content, theory….
	CO3	Analyse the real-world problems of….
	CO4	Propose the solution for ….
	CO5	Implement….
Course learning outcomes (CLO)	CLO 1: To provide an understanding of the processes undertaken to arrive at a suitable mathematical model, To teach the fundamental analytical techniques and computational methods used to develop insight into system behaviour	
	CLO 2:	
	CLO 3:	
	CLO 4:	
	….	
Briefly describing on course	This course is designed to introduce the definition, theory, and experiments… in the domain of … Students will learn how to solve the problem using mathematical analysis, information technology tools……	
References	[1] Giordano FR, Fox WP and Horton SB, *A First Course in Mathematical Modeling*, Brooks.Cole, Cengage Learning, 2014	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	

Assignment		
Mid-term exam	20%	Writing exam/ Multi-Choice Question….
Project / Presentation		
Final exam	70%	Oral exam /Writing exam..

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Modeling change	02	02		
2	The modelling process, proportionality, and Geomtric similarity	02	02		
3	Model fitting	02	02		
4	Experimental modeling	02	02		
5	Simulation modeling	02	02		
6	Discrete probabilistic modeling	02	02		
7	Optimization of discrete models	02	02		
8	Modeling using Graph theory	02	02		
9	Modeling with differential equations	02	02		
10	Modeling with systems of differential equations	02	02		

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

MAT2.014 OPTIMIZATION 2

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	In English: Optimization 2		
	In Vietnamese: Tối ưu hóa 2		
Course Code		**Credit points (ECTS)**	3
Academic year	2024-2025		
Lecturer	Lê Xuân Thanh		
Phone	+84 986815729		
Email	lxthanh@math.ac.vn		
Requirement	Required		
Prerequisites	Linear Programming, Linear Algebra, Calculus		
Time Commitment	Lecture:	18 hrs	
	Exercises/Tutorial	18 hrs	
	Practical/Labwork	0 hrs	
	Total	36 hrs	

DESCRIPTION

Course Objectives	CO1	**Identify a discrete optimization problem in a real-world context**
	CO2	**Formulate some simple problems in form of discrete optimization problems**
	CO3	**Basic algorithms in discrete optimization**
Course learning outcomes (CLO)	CLO 1: Able to model real-world problems as discrete optimization problems	
	CLO 2: Able to use appropriate algorithms to solve modelled problems	
	CLO 3: Able to use some optimization softwares to solve large-scaled discrete optimization problems	
Briefly describing on course	This course is designed to introduce the basic background in the domain of Discrete Optimization (Combinatorial Optimization). Students will learn how to model a problem in real-world context as a discrete optimization problem and then solve the modelled problem using appropriate algorithms and tools in this field.	
References	(10) L. A. Wolsey. *Integer Programming.* John Wiley & Sons (1998) (11) B. Korte and J. Vygen. *Combinatorial Optimization: Theory and Algorithms, 4th edition*. Springer (2008)	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	

Mid-term exam	40%	Writing exam
Final exam	50%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	**Chapter 1 Introduction** - Basic concepts of Discrete Optimization - Some applications in real-world context	2	2	0	Ref. (2)
2	**Chapter 2 Integer Programming** - Formulations - Basic modelling techniques - Advanced modelling techniques - Branch-and-bound algorithm - Cutting plane algorithm	8	8		Ref. (1)
3	**Chapter 3 Dynamic Programming** - Method decription - Applications	3	3		Ref. (1)
4	**Chapter 4 Introduction to ZIMPL and SCIP** - What and Why - How to install - First examples	2	2		Ref. (2)
5	**Chapter 5 Basic problems in Combinatorial Optimization** - Shortest path problem - Spanning tree problem - Matching problem	3	3		Ref. (2)

MAT2.015 STOCHASTICS PROCESSES

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Stochastic processes		
	Quá trình ngẫu nhiên		
Course Code	MAT2.015	**Credit points (ECTS)**	03
Academic year	2023-2024		
Lecturer	Cấn Văn Hảo		
Phone	0708079683		
Email	cvhao@math.ac.vn		
Requirement	- Some basic knowledge of calculus and probability		
Prerequisites	- Calculus I, Calculus II - Probability		
Time Commitment	Lecture	18 hrs	
	Exercises/Tutorial	18 hrs	
	Practical/Labwork	0 hrs	
	Total	36 hrs	

DESCRIPTION

Course Objectives	CO1	Understand the basic knowledge of discrete Markov chain
	CO2	Understand basic notions as classification of states, irreducibility, stationary distribution and the convergence of Markov chain
	CO3	Understand and implement basic methods to numerically solve and simulate the stationary distribution
Course learning outcomes (CLO)	CLO 1: Definition and real examples of discrete Markov chain and its properties	
	CLO 2: Basic concept of Markov chain including the classification of states, stationary distribution, and the convergence toward it	
	CLO 3: Some numerical method to calculate the stationary measure including linear algebra, iterative method, block iterative method, decomposition and aggregation methods	
Briefly describing on course	The course provides one of the most simplest but important stochastic processes called Markov chain. Several key concepts of stochastic processes, stationary distribution, asymptotical behaviours are presented. In addition, some numerical methods of solving the stationary measure are introduced and implemented.	
References	[1] William J. Stewart. *Probability, Markov chain, Queues and Simulation. The Mathematical Basis of Performance Modeling.*Princeton University Press 2009	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type

Attendance/Attitude	10%	
Mid-term exam	30%	Writing exam
Final exam	60%	Writing + practice exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Discrete-time Markov chains	1.5	1.5		[1, Section 9.2]
2	Classification of states	1.5	1.5		[1, Section 9.4]
3	Irreducibility	1.5	1.5		[1, Section 9.5]
4	The potential, fundamental, and reachability matrices				[1, Section 9.6]
5	Probability distribution	1.5	1.5		[1, Section 9.8]
6	Reversibility	1.5	1.5		[1, Section 9.9]
7	Introduction to numerical solutions of Markov chain	1.5	1.5		[1, Section 10.1]
8	Direct methods for stationary distribution	1.5	1.5		[1, Section 10.2]
9	Basic iterative methods for stationary distribution I	1.5	1.5		[1, Section 10.3]
10	Basic iterative methods for stationary distribution II	1.5	1.5		[1, Section 10.3, Subsection 10.3.4- Subsection 10.3.5]
11	Block iterative methods	1.5	1.5		[1, section 10.4]
12	Decomposition and Aggregation methods	1.5	1.5		[1, section 10.5]

Notes:

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- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

ICT2.010 IMAGE PROCESSING

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	In English: Image Processing		
	In Vietnamese: Xử lý ảnh		
Course Code	ICT2.010	**Credit points (ECTS)**	3
Academic year	2023-2024		
Lecturer	Nghiêm Thị Phương, Trần Giang Sơn		
Phone			
Email			
Requirement	- Elective		
Prerequisites			
Time Commitment	Lecture	27 hrs	
	Exercises/Tutorial	0 hrs	
	Practical/Labwork	9 hrs	
	Total	36 hrs	

DESCRIPTION

Course Objectives	CO1	Understand fundamental concepts and techniques in digital image processing such as image transformation, image enhancement, image filtering, image segmentation and morphology
	CO2	Practice students how to use these basic concepts and techniques in some image processing applications using Python language
Course learning outcomes (CLO)	CLO1	Understand basic concepts and techniques in digital image processing such as image transformation, image enhancement, image filtering, image segmentation and morphology
	CLO2	Be able to use basic image processing techniques in some image processing applications using Python language
Briefly describing on course	This course introduces fundamental concepts and techniques in digital image processing such as image transformation, image enhancement, image filtering, image segmentation and morphology. These concepts and techniques will be illustrated using Python language. At the end of the course, students are expected to: • Understand the basic concepts and techniques of image processing • Practice how to use these concepts and techniques using Python language	
References	(12) Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 4th Edition, Pearson, 2017 (13) Sandipan Dey, Python Image Processing Cookbook, 1st Edition, Packt Publishing, 2020	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	0%	
Mid-term exam	40%	Writing exam/ Moodle exam
Final exam	60%	Writing exam/ Moodle exam

MAIN CONTENTS

Class	Contents	Hours			Hours
		Lect.	Lect.	Lect.	
1	**Chapter 1. Introduction to Image Processing** - What is digital image processing? - History of digital image processing - Key stages in digital image processing	2			
2	**Chapter 2. Fundamentals of Image Processing** - Human visual system - Light and electromagnetic spectrum Imaging - Image representation - Image sensing and acquisition	2		1	
3	**Chapter 3. Histogram Processing** - What is image enhancement - Histogram processing	2		1	
4	**Chapter 4. Point Processing** - What is point processing - Negative images - Thresholding - Logarithmic transformation - Power law transforms	3		1	
5	**Chapter 5. Spatial Filtering 1** - Neighbourhood operations - What is spatial filtering? - Smoothing operations - Correlation and convolution	3		1	
6	**Chapter 6. Spatial Filtering 2** - First derivative filters - Second derivative filters - Combining filtering techniques	3		1	
7	**Chapter 7: Filtering in Frequency Domain** - The Fourier series & the Fourier transform - Image smoothing in frequency domain - Image sharpening in frequency domain	3		1	
8	**Chapter 8: Image Segmentation** - Segmentation problem - Finding points, lines and edges - Thresholding	3		1	
9	**Chapter 9: Morphological Image Processing** - What is morphology?	3		1	

	- Simple morphological operations - Compound operations - Morphological algorithms				
10	**Chapter 10: Color Image Processing** - Color fundamentals - Color models	3		1	

Notes:

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- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

Hanoi, dated…….

DIRECTOR DEPARTMENT OF ……

ICT2.013 ADVANCED PROGRAMMING WITH PYTHON
COURSE SYLLABUS

GENERAL INFORMATION

Course Title	In English: Advanced Programming With Python		
	In Vietnamese: Lập trình nâng cao với Python		
Course Code	ICT2.013	**Credit points (ECTS)**	4
Academic year	2023-2024		
Lecturer	Trần Giang Sơn, Nghiêm Thị Phương, Huỳnh Vinh Nam, Kiều Quốc Việt		
Phone			
Email			
Requirement	- Required		
Prerequisites	Basic programming, Object-oriented programming		
Time Commitment	Lecture	30 hrs	
	Exercises/Tutorial	0 hrs	
	Practical/Labwork	10 hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	CO1	Provide the concepts and techniques of several advanced features of Python programming
	CO2	Practice how to use these concepts and techniques to build several software applications/systems or data science projects in Python
Course learning outcomes (CLO)	CLO1	Understand the concepts and techniques of several advanced features of Python programming
	CLO2	Be able to use these concepts and techniques to build several software applications/systems or data science projects in Python
Briefly describing on course	Python is currently one of the most popular and useful programming language in the world. This course provides students with several popular advanced concepts and techniques of Python programming. The topics covered include the appliance of object-oriented concepts in Python language, the usage of Python in data manipulation and visualization and the graphical user interface programming with Python. After the course, students are expected to understand the provided concepts and techniques to develop the several software applications/systems or data science projects in Python.	
References	[1] Allen Downey, “Think Python: How to Think Like a Computer Scientist (3rd Edition)”, Oreilly & Associates Inc., 2024. [2] Burkhard A. Meier, “Python GUI Programming Cookbook: Use recipes to develop responsive and powerful GUIs using Tkinter (2nd Edition)”, Packt Publishing, 2021.	

	[3] Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data (2nd Edition)", O'Reilly Media, 2023.

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	0
Mid-term exam	40%	Project presentation / Moodle exam
Final exam	60%	Project presentation / Paper exam

MAIN CONTENTS

Class	Contents	Hours			References
		Lect.	Lect.	Lect.	
1	Introduction to Python programming	3		0	
2	Basics of Python language	6		2	
3	Object-oriented programming in Python	6		2	
4	Modules and Packages	3		1	
5	Introduction to Numpy	3		1	
6	Data manipulation with Pandas	3		1	
7	Data visualization with Matplotlib	3		1	
8	Graphical User Interface programming	3		2	

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions.*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

Hanoi, dated……

DIRECTOR DEPARTMENT OF ……

III. THIRD YEAR PROGRAM

1. Overview

No.	Code	Module	Lecturers
1	MAT3.001	Data Assimilation	Đoàn Thái Sơn
2	MAT3.002	Multivariate Statistics	Hồ Đăng Phúc
3	MAT3.003	Mathematical Finance	Nguyễn Hoàng Thạch
4	MAT3.004	Machine Learning: Optimization Approach	Lê Hải Yến
5	MAT3.005	Machine Learning: Statistical Approach	Cấn Văn Hảo
6	ICT3.013	Natural Language Processing	Phạm Quang Nhật Minh
7	ICT3.015	Computer Vision	Nguyễn Đức Dũng
8	MAT3.006	Group Project	
9	FR3.001	French 3.1	Trần Thị Phương Thảo, Nguyễn Tuấn Anh, Trương Thị Khánh Hoà, Invited lecturer
10	MS3.001	Scientific Writing and Communication	Tô Thị Mai Hương
11	FR3.002	French 3.2	Trần Thị Phương Thảo, Nguyễn Tuấn Anh, Trương Thị Khánh Hoà, Invited lecturer
12	MS3.002	Startups	Trần Minh Thu
13	MAT3.007	Internship	Đoàn Thái Sơn

2. Syllabus

MAT3.001 DATA ASSIMILATION

GENERAL INFORMATION

Course Title	Data Assimilation Đồng bộ hóa số liệu		
Course Code	*MAT3.001*	**Credit points (ECTS)**	4
Academic year	2023 -2024		
Lecturer	Prof. Đoàn Thái Sơn		
Phone			
Email	dtson@math.ac.vn		
Requirement	- Required		
Prerequisites	- Calculus I, Calculus II - Probability - Stochastic processes - Mathematical modelling		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	hrs	
	Total	40hrs	

DESCRIPTION

Course Objectives	CO1	Understand the basic knowledge of…
	CO2	Describe the content, theory….
	CO3	Analyse the real-world problems of….
	CO4	Propose the solution for ….
	CO5	Implement….
Course learning outcomes (CLO)	CLO 1: To provide a knowledge of methods and algorithms of data assimilation and a practical skill in dealing applictions of data assimilation.	
	CLO 2:	
	CLO 3:	
	CLO 4:	
	….	
Briefly describing on course	This course is designed to introduce the definition, theory, and experiments… in the domain of … Students will learn how to solve the problem using mathematical analysis, information technology tools……	
References	M. Asch, M. Bocquet and M. Nodet, *Data Assimilation : Methods, Algorithms and Applications*, SIAM 2016	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	

Assignment		
Mid-term exam	20%	Writing exam/ Multi-Choice Question….
Project / Presentation		
Final exam	70%	Oral exam ..Writing exam..

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Introduction to data assimilation and inverse problems	02	02		[1, Chapter 1]
2	Optimal control	02	02		[1, Chapter 2]
3	Variational data assimilation	02	02		[1, Chapter 2]
4	Statistical estimation	02	02		[1, Chapter 3]
5	Sequential data assimilation	02	02		[1, Chapter 3]
6	Nudging methods	02	02		[1, Chapter 4]
7	Reduced methods	02	02		[1, Chapter 5]
8	The ensemble Kalman filter	02	02		[1, Chapter 6]
9	Ensemble variational methods	02	02		[1, Chapter 7]
10	Application	02	02		[1, Part III]

MAT3.002 MULTIVARIATE STATISTICS

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Multivariate Statistics		
	Thống kê nhiều biến		
Course Code	MAT3.002	**Credit points (ECTS)**	4
Academic year	2023 - 2014		
Lecturer	**Ho Dang Phuc**		
Phone	0973949628		
Email	hdphuc@math.ac.vn		
Requirement	- Required		
Prerequisites	- Calculus I, Calculus II - Statistics - Probability		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	CO1	
	CO2	
	CO3	
	CO4	
Course learning outcomes (CLO)	CLO 1: An understanding of the concepts and statistical methods of multivariate analysis for describing and analyzing multivariate data.	
	CLO 2:	
	CLO 3:	
	CLO 4:	
	CLO 5:	
Briefly describing on course	This course is designed to introduce the definitions, theory, analysis methods, and calculation tools in the domain of statistical data analysis. Students will learn how to solve the elementary problems of data analysis using statistical analysis tools.	
References	(14) Richard A. Johnson and Dean W. Wichern, *Applied Multivariate Statistical Analysis, 6th Edition*, Pearson 2007.	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	0%	
Mid-term exam	40%	Writing exam

Project / Presentation	0%	
Final exam	50%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Aspect of multivariate analysis	01	01		[1, Chapter 1]
2	Matrix analysis and random vectors	01	01		[1, Chapter 2]
3	Sample geometry and random sampling	01	01		[1, Chapter 3]
4	The multivariate normal distribution	01	01		[1, Chapter 4]
5	Inference about a mean vector	02	02		[1, Chapter 5]
6	Comparison of several multivariate means	02	02		[1, Chapter 6]
7	Multivariate linear regression models	02	02		[1, Chapter 7]
8	Principle component analysis	02	02		[1, Chapter 8]
9	Factor analysis and inference for structured covariance matrices	02	02		[1, Chapter 9]
10	Canonical correlation analysis	02	02		[1, Chapter 10]
11	Discrimination and classification	02	02		[1, Chapter 11]
12	Clustering, Distance method and ordination	02	02		[1, Chapter 12]

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ... for each class sessions*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

MAT3.003 MATHEMATICAL FINANCE

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Mathematical Finance Toán tài chính		
Course Code	MAT3.003	**Credit points (ECTS)**	4
Academic year			
Lecturer	Nguyễn Hoàng Thạch		
Phone	0839530167		
Email	nhthach@math.ac.vn		
Requirement	- Required - Elective - Free Elective		
Prerequisites	Calculus (I & II), Probability		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	To provide an understanding of the basic concepts of finance such as the theory of interest, option pricing, hedging.
Course learning outcomes (CLO)	Students are expected to acquire knowledge about mathematical models and techniques towards problems in optimization appearing in finance.
Briefly describing on course	This course provides an introduction to financial mathematics and financial engineering for undergraduate students who have completed a three- or four-semester sequence of calculus courses. It introduces the theory of interest, discrete and continuous random variables and probability, stochastic processes, linear programming, the Fundamental Theorem of Finance, option pricing with Black-Scholes model, hedging, and portfolio optimization.
References	(1) J. R. Buchanan, An Undergraduate Introduction to Financial Mathematics,World Scientific, 2006. (2) S. Ross, An Elementary Introduction to Mathematical Finance (Third Edition), Cambridge University Press, 2011.

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Mid-term exam	30%	Writing exam
Final exam	60%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Interest rate, present value analysis	2	2	0	
2	Probability, normal random variables	2	2		
3	Brownian motion and geometric Brownian motion	2	2		
4	Option pricing via arbitrage	2	2		
5	The arbitrage theorem	2	2		
6	The Black-Scholes-Merton formula for option pricing	2	2		
7	Derivation of the Black-Scholes-Merton formula	2	2		
8	Additional results on options	2	2		
9	Expected utility, value at risk analysis	2	2		
10	Optimization	2	2		

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
- *Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions*
- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

MAT3.004 MACHINE LEARNING: OPTIMIZATION APPROACH

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Machine Learning: Optimization Approach		
	Tối ưu trong Học máy		
Course Code	MAT3.004	**Credit points (ECTS)**	04
Academic year	2023-2024		
Lecturer	Dr. Le Hai Yen		
Phone	0786662296		
Email	lhyen@math.ac.vn		
Requirement	- Required		
Prerequisites	● Calculus I, Calculus II ● Linear algebra ● Optimization 1		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	0 hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	CO1	Analyse basic problems in machine learning as optimization problems
	CO2	Understand the basic knowledge of optimization: convex sets, convex functions, optimality condition, duality,...
	CO3	Understand and implement fundamental algorithms for solving optimization problems in machine learning
Course learning outcomes (CLO)	CLO 1: Recognize, formulate, and analyse basis problems in machine learning	
	CLO 2: Understand the optimization methods for solving unconstrained and constrained optimization problems	
	CLO 3: Be able to apply optimization methods and packages (Python) to solve optimization problems arising from machine learning	
	CLO 4: Design experiments to evaluate and compare different machine learning techniques on real-world problems	
Briefly describing on course	The course focuses on aspects of optimization that are more relevant to machine learning (ML); it builds a foundation for analysing and solving a problem in ML. Materials can be separated roughly into two areas: qualitative properties of optimization problems in ML and optimization methods for solving problems in ML.	

References	(1) Charu C. Aggarwal, Linear Algebra and Optimization for Machine Learning, Springer 2020. (2) Amir Beck, Introduction to Nonlinear Optimization: Theory, Algorithms and Applications with Matlab, SIAM 2014.

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	15%	
Mid-term exam	15%	Writing exam/ Multi-Choice Question
Project / Presentation	0%	
Final exam	60%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	**Introduction**: Basic problems in machine learning as optimization problems ● Matrix factorization ● Clustering ● Classification and regression ● Outlier detection Properties of optimization problems in machine learning	2	2	0	[1, Sect. 1.4] [1, Sect. 4.5]
2	**Optimization basics:** An introduction to convexity and duality ● Convex sets and functions ● Convex optimization problems ● Duality	2	2		[1, Sect. 4.3] [1, Sect. 6.4.2]
3	**Optimization basics:** Optimality conditions ● Local and global optimality ● Existence of optimal solutions ● Feasible/descent directions ● Necessary and sufficient conditions for local and global optimality in convex programming	2	2		[2, Chap. 2] [2, Chap. 9]
4	**The gradient descent method** ● Univariate optimization	2	2		[1, Sect. 4.2.1] [1, Sect. 4.4.3]

	● Descent direction methods ● Gradient descent method				[2, Chap. 4]
5	**Gradient descent methods in machine learning** ● Linear regression ● Logistic regression	2	2		[1, Sect. 4.7] [1, Sect. 4.8.3]
6	**Gradient descent methods in machine learning** ● Support vector machine (SVM) ● SVM dual ● Weston-Watkins SVM	2	2		[1, Sect. 4.8.2] [1, Sect. 6.4.4] [1, Sect. 4.9.1]
7	**The Newton method** ● Pure Newton method ● Newton method with line-search	2	2		[2, Chap. 5]
8	**Newton method in machine learning** ● Linear regression ● SVM ● Logistic regression	2	2		[1, Sect 5.5]
9	**Constrained optimization** ● Introduction ● Projected gradient descent method ● Linear equality and inequality constraints ● Sequential quadratic programming	2	2		[2, Chap. 9] [1, Chap. 6]
10	**Review**	2	2		

Notes:

- *Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).*
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- *Practicals mostly refer to Lab- work or outside practice such as field trip.*

MAT3.005 MACHINE LEARNING: STATISTICAL APPROACH

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	Machine Learning: Statistical Approach		
	Thống kê trong Học máy		
Course Code	MAT3.005	**Credit points (ECTS)**	04
Academic year	2023 -2024		
Lecturer	Dr. Cấn Văn Hảo		
Phone			
Email	cvhao@math.ac.vn		
Requirement	- Required		
Prerequisites	- Calculus I, Calculus II - Statistics - Probability		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	20 hrs	
	Practical/Labwork	0 hrs	
	Total	40 hrs	

DESCRIPTION

Course Objectives	CO1	Statistical approach and methods in machine learning
	CO2	
	CO3	
Course learning outcomes (CLO)	CLO 1: Build supervised, unsupervised, and reinforcement learning models using both Python and R.	
	CLO 2:	
	CLO 3:	
	CLO 4:	
Briefly describing on course	Build supervised, unsupervised, and reinforcement learning models using both Python and R	
References	[1] P. Dangeti, *Statistics for Machine Learning*, Packt Publishing, 2017 [2] Kevin P. Murphi, *Machine learning: A probability perpective.* MIT press (2012).	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	
Assignment	0%	
Mid-term exam	30%	Writing exam/ Multi-Choice Question

Final exam	60%	Writing exam

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Statistical terminology for model building and validation	02	02		[1, Chapter 1]
2	Machine learning terminology for model building and validation	02	02		[1, Chapter 1]
3	Parallelism of Statistics and Machine Learning	02	02		[1, Chapter 2]
4	Logistic Regression Versus Random Forest	02	02		[1, Chapter 3]
5	Tree-Based Machine Learning Models	02	02		[1, Chapter 4]
6	K-Nearest Neighbors and Naive Bayes	02	02		[1, Chapter 5]
7	Support Vector Machines and Neural Networks	02	02		[1, Chapter 6]
8	Recommendation Engines	02	02		[1, Chapter 7]
9	Unsupervised Learning	02	02		[1, Chapter 8]
10	Reinforcement Learning	02	02		[1, Chapter 9]

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ICT3.013 NATURAL LANGUAGE PROCESSING

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	In English: Natural Language Processing		
	In Vietnamese: Xử lý ngôn ngữ tự nhiên		
Course Code	ICT3.013	**Credit points (ECTS)**	3
Academic year	2023 - 2024		
Lecturer	Pham Quang Nhat Minh		
Phone	0962053138		
Email	minhpham0902@gmail.com		
Requirement			
Prerequisites	Proficiency in Python Basic Probability and Statistics Proficiency in using basic Linux commands		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	3 hrs	
	Practical/Labwork	7 hrs	
	Total	30 hrs	

DESCRIPTION

Course Objectives	CO1	Provide to students a big picture of NLP field
	CO2	Describe Machine Learning models used in NLP
	CO3	Provide essential practical techniques to solve NLP tasks
Course learning outcomes (CLO)	CLO 1: Students understand essential knowledge and techniques in building NLP models such as POS tagging, text classification, language models, etc.	
	CLO 2: Students can implement some NLP models using Python and NLP/Machine Learning frameworks	
	CLO 3: Students understand how to use NLP to sove real-world problems	
Briefly describing on course	Natural language processing is a subfield of artificial intelligence, which aims to make computers understand human language. In this course, students will learn about natural language processing from basic to more advanced knowledge. Students will gain knowledge and skills via theory lessons and hand-ons assignments and projects. After this course, students can use techniques learned in this course to solve real-world NLP problems.	
References	(1) Jurafsky, D. Speech & language processing. (3rd edition), online draft version: https://web.stanford.edu/~jurafsky/slp3/	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	

Assignment	30%	
Final exam	60%	Writing exam/ Multi-Choice Question

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Introduction - Introduction to NLP course - Introduction to NLP - Getting started with Text Analysis - Vietnamese NLP Pipeline	2	1	0	
2	Naive Bayes and Sentiment Classification	2	1		
3	Perceptron Algorithm	2	1		
4	Logistic Regression	2	1		
5	Feed-forward Neural Networks	2	1		
6	N-gram Language Models, Vector Semantics	2	1		
7	Sequence Labeling with HMM, CRF	2	1		
8	Recurrent Neural Networks	2	1		
9	Transformers and Pretrained Language Models	3	0		
10	Fine-Tuning and Masked Language Models	3	0		

Notes:

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ICT3.015 COMPUTER VISION

COURSE SYLLABUS

GENERAL INFORMATION

Course Title	In English: Computer Vision		
	In Vietnamese: Thị giác máy tính		
Course Code	ICT3.015	**Credit points (ECTS)**	03
Academic year	2023-2024		
Lecturer	Nguyễn Đức Dũng		
Phone	0978293789		
Email	nddung@ioit.ac.vn		
Requirement	- Required (DS) - Elective (ICT)		
Prerequisites	Linear Algebra, Probability and Statistics, Algorithms and Data Structures, Image Processing, Machine Learning, Deep Learning		
Time Commitment	Lecture	20 hrs	
	Exercises/Tutorial	0 hrs	
	Practical/Labwork	10 hrs	
	Total	30 hrs	

DESCRIPTION

Course Objectives	CO1	Provides students with theoretical and practical aspects of computer vision with images. Connect issues from computer vision to human vision
	CO2	Provides students with basic foundation of 2D and 3D computer vision
Course learning outcomes (CLO)	CLO 1	Be familiar with the major technical approaches involved in computer vision
	CLO 2	Be able to build basic computer vision applications
Briefly describing on course	This course provides students with basic concepts and techniques of computer vision including the relation between computer vision and human vision, the basic foundation of 2D and 3D computer vision, the common problems in 2D and 3D vision such as image recognition, object detection, object tracking and 3D reconstruction. After the course, the students are expected to be able to build some simple computer vision applications either in 2D or 3D.	
References	[1] Richard Szeliski, Computer Vision: Algorithms and Applications (2nd Edition), Springer, 2022 [2] David Forsyth, Jean Ponce, Computer Vision: A Modern Approach (2nd Edition), Pearson, 2011	

ĐÁNH GIÁ/ASSESSMENT/EVALUATION

	Percentage	Type
Attendance/Attitude	10%	

Mid-term exam	40%	Writing exam
Final exam	50%	Group project

MAIN CONTENTS

Class	Contents	Hours			Ref./Resources
		Lect.	Exr.	Prc.	
1	Introduction to computer vision	3	0		
2	Image recognition	3	2		
3	Object detection	3	2		
4	Object tracking	4	3		
5	3D reconstruction	4	3		
6	Project Presentation	3	0		

Notes:

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