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MTH00051

APPLIED MATHEMATICS AND STATISTICS

COURSE INTRODUCTION

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GENERAL INFORMATION

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1. Course name: Applied Mathematics and Statistics
2. Course name (in Vietnamese): Toán ứng dụng và thống kê
3. Course ID: MTH00051
4. Knowledge block: General Education Knowledge
5. Number of credits: 4
6. Credit hours for theory: 45
7. Credit hours for practice: 30
8. Credit hours for self-study: 90
9. Prerequisite: none
10. Prior-course: none

COURSE DESCRIPTION

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Systematize math knowledge learned in the first 3 semesters of university (calculus, linear algebra, probability-statistics), introduce algorithmic skills to be able to solve problems related to machine learning, data analysis. Specifically, including 3 blocks of knowledge:

- ❑ Computational methods for matrix algebra.
- ❑ Computational methods for convex optimization
- ❑ Probability models

COURSE OUTCOMES

CO	Description
G1.1	Establish, organize, operate, and manage the team.
G1.2	Participate in group discussions
G1.3	Writing a technical report.
G2.1	Be able to explain terminologies.
G2.2	Reading English lectures and textbooks.
G3.1	Be able to explain basic concepts.

COURSE OUTCOMES

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CO	Description
G3.2	Ethics.
G3.3	Be able to self study.
G4.1	Be able to use the learned models.
G5.1	Be able to describe the learned mathematical and statistical methods
G5.2	Be able to design an algorithm.

CONTENT

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ID	Topic
1	System of linear equations . Introduction to system of linear equations . System of linear equations and matrices Ax = b . Equation systems of the special form . Generic equation systems . Gaussian elimination
2	Vector . Vector and vector operations . Norm, Dot product, Distance . Basis and Orthogonal Basis . Gram-Schmidt process

ID	Topic
3	Matrix . Matrix and matrix operations . Special matrix forms (sparse, symmetrical, triangular, diagonal matrices) . Invertible matrices . Determinant . Matrix equations
4	Matrix decompositions . LU decomposition . QR decomposition using Gram - Schmidt. . Eigenvalues and Eigenvectors . Diagonalization . Introduction to Singular Value Decomposition

CONTENT

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ID	Topic
5	Applications . Some applications in Information Technology . Some applications in Physics/Chemistry . Some applications in Polynomial interpolation
6	Midterm review
7	Introduction to optimization . One variable optimization . Sensitivity and Robustness . Multivariable optimization

ID	Topic
8	Convex optimization . Convex and concave functions . Least square method . Data fitting
9	Introduction to probability . Axiom of probability . Random variables . Conditional probability formula
10	Probability models . Introduction to statistics . Markov chains
11	Review

ASSESSMENTS

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Topic	Description	Ratio (%)
A1. Assignments Weekly	HW#1: System of linear equations. HW#2: Vector and Matrix HW#3: Matrix decompositions. HW#4: Least square optimization. HW#5: Markov chain.	0%
A2. Projects Weekly Labs	Lab#1: Gaussian algorithm. Lab#2: QR process. Lab#3: Applications. Lab#4: Data fitting. Lab#5: Markov chains.	15%
A3. Exams		85%
A3.1. Final project Labs	In-class programming exam on computer	25%
A3.2 Midterm exam	Closed book exam. Describe the understanding of different topics, analyze & program to solve problems	20%
A3.3 Final exam	Closed book exam. Describe the understanding of different topics, analyze & program to solve problems	40%

RESOURCES

- Textbooks: Stephen Boyd, Lieven Vandenberghe, *Introduction to Applied Linear: Algebra, Matrices, and Least Squares*, Cambridge University Press, 2018 (available in internet).

- Others:

[1] G. H. Golub, C. F. Van Loan, *Matrix computations*, 4th edition, Johns Hopkins University Press, 2013.
[2] Y. Saad, *Iterative methods for sparse linear systems*, 2nd edition, Society for Industrial and Applied Mathematics, 2003.
[3] S. Boyd, L. Vandenberghe, *Convex optimization*, 7th edition, Cambridge University Press, 2009.
[4] R. V. Hogg, J. W. McKean, A. T. Craig, *Introduction to mathematical statistics*, 7th edition, Pearson, 2013.
[5] Đ. Đ. Trọng, Đ. N. Thanh, *Lý thuyết thống kê*, NXB ĐHQG Tp HCM, 2016.
[6] Đ. N. Thanh et. al., *Bài tập và thực hành lý thuyết thống kê*, NXB ĐHQG Tp HCM, 2016.
[7] Zed Shaw, *Learn Python: The Hard Way*. Addison Wesley, 3rd Edition, 2014

GENERAL REGULATIONS & POLICIES

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- All students are responsible for reading and following strictly the regulations and policies of the school and university.
- Students who are absent for more than 3 theory sessions are not allowed to take the exams.
- For any kind of cheating and plagiarism, students will be graded 0 for the course. The incident is then submitted to the school and university for further review.
- Students are encouraged to form study groups to discuss on the topics. However, individual work must be done and submitted on your own.