Course guide
230384 - MAAP - Matrix Algebra, Accelerated Program

Last modified: 25/05/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
MASTER'S DEGREE IN CYBERSECURITY (Syllabus 2020). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Good knowledge of first course in linear algebra. In particular, the student must be familiarized with the concepts of vectors, matrices, linear equations, inner product, determinants, vector spaces, linear independence, bases, eigenvalues and eigenvectors. These conceptes will be reviewed at the beginning of the course.
Basic Matlab programming skills.

TEACHING METHODOLOGY

- Lectures.
- Presentation of a journal or conference paper previously agreed with the professor by the student.

LEARNING OBJECTIVES OF THE SUBJECT

After passing the course, the student should be able to
• use and explain some basic tools in matrix algebra;
• identify scientific problems where tools from matrix algebra can be powerful;
• apply the matrix algebra knowledge to solve and analyse the identified problems;
• combine several partial problems and solutions to solve and analyse more complex problems.

STUDY LOAD

Type	Hours	Percentage
Hours large group	24,0	32.00
Self study	51,0	68.00

Total learning time: 75 h

CONTENTS

introduction

Description:
Obejctives, scope and organization of the course.

Full-or-part-time: 0h 30m
Theory classes: 0h 30m

I. Vector spaces and basic linear algebra

Description:
1. Vector Spaces
1.1. Linear Vector Spaces
1.2. Subspaces. Examples.
1.3. Linear Dependence and Independence. Bases and Dimension.
1.4. Geometrical considerations: Vector Norm, Inner Product and Orthogonality.
2. Basic Matrix Algebra
2.1 Terminology and Basic Operations of matrices.
2.2 Submatrices and Partitioned Matrices.
2.3 Special Matrices.
2.4 Linear Spaces: Range and Null Subspaces, Rank of matrices and Norm of matrices.
2.5 Inverse Matrix, Determinant and Trace.
2.6 Kronecker Product and vec operator.

Full-or-part-time: 8h
Theory classes: 8h

II Eigensystems of Matrices

Description:
3. Eigenvalues and Eigenvectors
3.1 Definition and Basic Results.
3.2 Diagonalization and Similarity Transformations.
3.3 Defective matrices. Jordan Form.
3.4 Schur Decomposition.
3.5 Normal Matrices. Eigenvectors and Eigenvalues of the Correlation Matrix.

4. SVD Decomposition and advanced topics on eigensystems
4.1 SVD Decomposition.
4.2 Generalized Eigenvalue Problem.
4.3 Perturbation of eigensystems.

Full-or-part-time: 8h
Theory classes: 8h

III Linear Systems

Description:
5. Solutions of Linear Systems. Theory and Methods.
5.1 Existence and number of Solutions to Ax=b
5.2 Solution of Triangular systems. Gauss Elimination.
5.3 LU decomposition. Cholesky Decomposition

6. Least Squares Problem.
6.1 Introduction
6.2 QR factorization and LS solution
6.3 SVD decomposition and LS solution.
6.4 Weighted Least Squares Problem.
6.5 Moore-Penrose Generalized Inverse.
6.6 Total Least Squares Problem.

Full-or-part-time: 7h 30m
Theory classes: 7h 30m

GRADING SYSTEM

- Attendance is mandatory.
- Short individual assignments during the course (20%)
- Journal or congress paper presentation individually or in groups (40%)
- Final Exam (40%)

Note: depending on the number of enrolled students, the grading system might change after agreement with the students.

BIBLIOGRAPHY

Basic:
- Horn, Roger A.; Johnson, Charles R. Matrix analysis [on line]. Cambridge: Cambridge university press, 2012 [Consultation: 22/09/2022]. Available on: https://web-s-ebscohost-com.recursos.biblioteca.upc.edu/ehost/ebookviewer/ebook?sid=dd4acb84-e80f-458b-8dad-e5b04708320c%40redis&vid=0&format=EB. ISBN 9780521548236.

Complementary:
- Golub, Gene H.; VanLoan, Charles F. Matrix computations. 4th ed. Baltimore, Md: Johns Hopkins, 2013. ISBN 9781421407944.
- Noble, Ben; Daniel, James W. Applied linear algebra. 3rd ed. Englewood Cliffs: Prentice Hall, 1988. ISBN 9780130409577.

RESOURCES

Computer material:
- Apunts d'Àlgebra Matricial. Lecture slides
- Exercises d'Àlgebra Matricial. Exercises