On-line course materials

MATH10212 - Linear Algebra B

Year: 1 - **Semester:** 2 - **Credit Rating:** 15

Requisites

Corequisites
MATH10232 Calculus and Applications B
Prerequisites
MATH10111 Sets, Numbers and Functions B

Aims

This course unit aims to introduce the basic ideas and techniques of linear algebra for use in many other lecture courses. The course will also introduce some basic ideas of abstract algebra and techniques of proof which will be useful for future courses in pure mathematics.

Brief Description

This core course aims at introducing students to the fundamental concepts of linear algebra culminating in abstract vector spaces and linear transformations. The course starts with systems of linear equations and some basic concepts of the theory of vector spaces in the concrete setting of real linear n-space, Rn. The course then goes on to introduce abstract vector spaces over arbitrary fields and linear transformations, matrices, matrix algebra, similarity of matrices, eigenvalues and eigenvectors. The subject material is of vital importance in all fields of mathematics and in science in general.

Learning Outcomes

On successful completion of this course unit students will be able to

solve systems of linear equations by using Gaussian elimination to reduce the augmented matrix to row echelon form or to reduced row echelon form;

understand the basic ideas of vector algebra: linear dependence and independence and spanning;

be able to apply the basic techniques of matrix algebra, including finding the inverse of an invertible matrix using Gauss-Jordan elimination;

know how to find the row space, column space and null space of a matrix, and be familiar with the concepts of dimension of a subspace and the rank and nullity of a matrix, and to understand the relationship of these concepts to associated systems of linear equations;

be able to find the eigenvalues and eigenvectors of a square matrix using the characteristic polynomial and will know how to diagonalize a matrix when this is possible;

be able to recognize and invert orthogonal matrices;

be able to orthogonally diagonalize symmetric matrices;

be able to find the change-of-basis matrix with respect to two bases of a vector space;

be familiar with the notion of a linear transformation and its matrix.

Future topics requiring this course unit

Almost all Mathematics course units.

Syllabus

Linear Equations in Linear Algebra: Systems of Linear Equations - Row Reduction and Echelon Forms - Vector Equations - The Matrix Equation Ax=b - Solution Sets of Linear Systems - Applications of Linear Systems - Linear Independence - Introduction to Linear Transformations - The Matrix of a Linear Transformation [Lay, Chapter 1, 6 lectures]

Matrix Algebra: Matrix Operations - The Inverse of a Matrix - Characterizations of Invertible Matrices - Partitioned Matrices - Matrix Factorizations - Subspaces of Rn - Dimensions and Rank [Lay, Chapter 2, 4 lectures]

Determinants: Introduction to Determinants - Properties of Determinants - Cramers Rule, Volume, and Linear Transformations [Lay, Chapter 3, 4 lectures]

Vector Spaces: Vector Spaces and Subspaces - Null Spaces, Column Spaces, and Linear Transformations - Linearly Independent Sets; Bases - Coordinate Systems - The Dimension of Vector Space Rank - Change of Basis [Lay, Chapter 4, 6 lectures]

Eigenvalues and Eigenvectors: Eigenvectors and Eigenvalues - The Characteristic Equation Diagonalization - Eigenvectors and Linear Transformations - Complex Eigenvalues [Lay, Chapter 5, 6 lectures]

Orthogonality: Inner Product, Length, and Orthogonality - Orthogonal Sets - Orthogonal Projections - The Gram- Schmidt Process - Inner Product Spaces - Applications of Inner Product Spaces [Lay, Chapter 6, 4 lectures]

Symmetric Matrices: Diagonalization of Symmetric Matrices [Lay, Chapter 7, 2 lectures]

Teaching & Learning Process (Hours Allocated To)

Lectures	Tutorials/ Example Classes	Practical Work/ Laboratory	Private Study	Total

33	11	0	106	150

Assessment and Feedback

Assessment:

Attendance at supervisions: weighting 5%

Submission of coursework at supervisions: weighting 5%

In-class test weighting 15%

Two and a half hour end of semester examination: weighting 75%

Further Reading

The course is based on the textbook:

D. C. Lay, Linear Algebra and Its Applications, Pearson Education, 2010 (and previous editions).

Staff Involved

Prof Alexandre Borovik - Lecturer

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