DEPARTMENT OF CIVIL ENGINEERING
COURSE SYLLABUS

Course Details					
Code		**Academic Year**			**Semester**
MAT106		1			Spring
Title		**T**	**A**	**L**	**ECTS**
Linear Algebra		2	2	1	6

Language	German					
Level	**Undergraduate**	X	**Graduate**		**Postgraduate**	
Department / Program	Civil Engineering					
Forms of Teaching and Learning	Formal					
Course Type	**Compulsory**	X	**Elective**			
Objectives	This course covers matrix theory and linear algebra. Emphasis is given to topics that will be useful in other disciplines, including systems of equations, vector spaces, determinants and eigenvalues. After successfully completing this course, you will have a good understanding of the following topics and their applications: systems of linear equations, row reduction and echelon forms, matrix operations, linear dependence and independence, vector spaces and subspaces, orthogonal bases and orthogonal projections, Gram-Schmidt process, linear models and least-squares problems, determinants and their properties, Cramer's Rule, eigenvalues and eigenvectors, diagonalization of a matrix, Markov matrices.					
Content	- Vectors, Matrices - Linear Equations, Gauss-Jordan - Vector Spaces, the four fundamental subspaces, Nullspace, Column Space - Dimension, Basis, Span - Orhogonal vectors and subspaces, projections - Orthogonal matrices and Gram-Schmidt - Determinants, Cramer'srule - Eigenvalues, Eigenvectors, Diagonalization and Powers of A - Differential Equations, exp(A) - Markov Matrices					
Prerequisites	None					
Coordinator						
Lecturer(s)						
Assistant(s)						
Work Placement	None					

Recommended or Required Reading	
Books / Lecture Notes	- Strang, Gilbert. *Lineare Algebra*. Springer-Verlag Berlin Heidelberg GmbH,2003. - Teschl, Gerald; Teschl, Susanne. Mathematik für Informatiker, Band 1:Diskrete - Mathematik und Lineare Algebra. Springer-Verlag Berlin Heidelberg 2006, 2007.
Other Sources	- Göllmann, Laurenz et.al. *Mathematik für Ingenieure: Verstehen, Rechnen, Anwenden*. Springer Vieweg,2017.

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	- Gilbert Strang. *18.06SC Linear Algebra.* Fall 2011. Massachusetts Institute of Technology: MIT OpenCourseWare,https://ocw.mit.edu. License:Creative CommonsBY-NC-SA. Accessed 2020-03-14.
Additional Course Material	
Documents	https://www.geogebra.org/u/canan.yildiz
Assignments	-
Exams	-

Course Composition		
Mathematics und Basic Sciences	100	%
Engineering		%
Engineering Design		%
Social Sciences		%
Educational Sciences		%
Natural Sciences		%
Health Sciences		%
Expert Knowledge		%

Assessment

Activity	Count	Percentage (%)
Midterm Exam	1	40
Quiz		
Assignments	1	10
Attendance		
Recitations		
Projects		
Final Exam	1	50
	Total	**100**

ECTS Points and Work Load

Activity	Count	Duratio n	Work Load (Hours)
Lectures	14	2	28
Self-Study	1	62	6 2
Assignments	10	3	30
Presentation / Seminar Preparation			
Midterm Exam	1	3	3
Recitations	14	2	2 8
Laboratory	14	1	14
Projects			

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Final Exam	1	3	3
		Total Work Load	**168**
		ECTS Points (Total Work Load / 28)	**6**

Learning Outcomes

1	Solving Ax = b for square systems by elimination (pivots, multipliers, back substitution, invertibility of A, factorization into A = LU)
2	Complete solution to Ax = b (column space containing b, rank of A, null space of A and special solutions to Ax = 0 from row reduced R)
3	Basis and dimension (bases for the four fundamental subspaces)
4	Least squares solutions (closest line by understanding projections)
5	Orthogonalization by Gram-Schmidt (factorization into A = QR)
6	Properties of determinants (leading to the cofactor formula and the sum over all n! permutations, applications to inv(A) and volume)
7	Eigenvalues and eigenvectors (diagonalizing A, computing powers A^k and matrix exponentials to solve difference and differential equations)
8	Linear transformations and change of basis (connected to the Singular Value Decomposition - orthonormal bases that diagonalize A)
9	Linear algebra applications (graphs and networks, Markov matrices, linear programming)

Weekly Content

1	Introduction, vectors
2	Span, bases, linear independence, vector spaces, subspaces
3	Linear transformations and matrices
4	Matrix multiplication and composition, systems of equations and their geometry
5	Elimination with matrices, Gauss-Jordan algorithm
6	Null space (Ax = 0), column space, row space and their dimensions
7	Dot product, orthogonal vectors, projections
8	Orthogonal projections, Least Squares
9	Midterm Exams
10	Orthonormal vectors and Gram-Schmidt
11	Properties and applications of determinants
12	Eigenvectors and eigenvalues
13	Diagonalization
14	Markov matrices
15	Summary, exercise

Contribution of Learning Outcomes to Program Objectives (1-5)

	P1	P2	P3	P4	P5	P6	P7

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1	5	5	4			3	1
2	5	5	4			3	1
3	5	5	4			3	1
4	5	5	4			3	1
5	5	5	3			3	1
6	5	5	3			3	1
7	5	5	3			3	1
8	5	5	3			3	1
9	5	5	3			3	1

Contribution Level	1: Low 2: Low-intermediate 3: Intermediate 4: High 5: Very High
Compiled by:	
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