COURSE SYLLABUS AND COURSE REQUIREMENTS
ACADEMIC YEAR 2023/24 SEMESTER AUTUMN

Course title	*Engineering Mathematics 3*
Course Code	*MSB595AN*
Hours/Week: le/pr/lab	*2/2/0*
Credits	*4*
Degree Programme	*BSc*
Study Mode	*Full time*
Requirements	*Mid-semester grade*
Teaching Period	*autumn*
Prerequisites	*Engineering Mathematics 2.*
Department(s)	*Department of Engineering Mathematics*
Course Director	*Ákos PILGERMÁJER*
Teaching Staff	*Ákos PILGERMÁJER*

COURSE DESCRIPTION

A short description of the course (max. 10 sentences).
Neptun: Instruction/Subjects/Subject Details/Basic data/Subject description

In the first half of the course: introduction to the classical fields of linear algebra (matrices, determinants) and elements of modern fields (vectorspaces, linear maps, eigenproblem) through solving linear systems of equations.
In the second half: introduction to statistics to help them recognize random phenomena, build appropriate model, learn necessary theoretical background and statistical computations to be able to apply these in their engineering fields.

SYLLABUS

Neptun: Instruction/Subjects/Subject Details/Syllabus

1. GOALS AND OBJECTIVES

Goals, student learning outcome.
Neptun: Instruction/Subjects/Subject Details/Syllabus/Goal of Instruction

In the first half of the course: introduction to the classical fields of linear algebra (matrices, determinants) and elements of modern fields (vectorspaces, linear maps, eigenproblem) through solving linear systems of equations.
In the second half: introduction to statistics to help them recognize random phenomena, build appropriate model, learn necessary theoretical background and statistical computations to be able to apply these in their engineering fields.

2. COURSE CONTENT

Neptun: Instruction/Subjects/Subject Details/Syllabus/Subject content

TOPICS

LECTURE

1 Linear systems of equations (LS). Algebraic representation, Gauss-Jordan elimination.
2 Linear systems of equations (LS). Vector representation. Vectorspace, subspace, span, linear independence, basis, dimension, coordinates with respect to a basis.
3 Linear systems of equations (LS). Matrix representation. Algebra of matrices, powers and inverse of matrices.
4 Matrix as linear map. Fundamental subspaces: row, column, null spaces.Rank of a matrix. Dimension theorem for matrices. Linear transformations of the plane: rotation, scaling, reflection, projection onto a subspace (line, plane).
5 Change of bases. Matrix of a linear map. Determinants. Properties under rowequivalent operations. Determinant of a product matrix. Determinant as measure of area, volume.
6 Eigenvalue problem.
7 Euclidean spaces. Inner product, norm, distance of vectors. Orthogonality, orthonormal systems. Gram-Schmidt-ortogonalization. Orthogonal complement. The null and rowspace of a matrix are orthogonal. Least square method
8 Mathematical statistics. Introduction. Exploratory data analysis: graphical and numerical representation of data sets in one or two variables.

9 Producing data: sampling, experiments. Need for probability concepts. Probability: sample space, event, probability measure, probability rules. Disjoint and independent events, conditional probability law of total probability, Bayes theorem.
10 Random variables (discrete or continuous). Distribution and density functions. Expected value and variance. Jointly distributed random variables, their joint, marginal, conditional distributions. Independence, covariance, correlation.
11 Common distributions and their properties. Law of large numbers, central limit theorem and the fundamental law of statistics.
12 Inferential statistics. Estimates of parameters with points and intervals. Maximum likelihood method.
13 Hypothesis testing. General considerations. The u-, t-, F-, Chi^2-tests.

PRACTICE

1 Algebraic form of LS. Domain and solution set of LS. (Non-)Homogeneous, (in)consistent LS. Row equivalent operations, Gauss-Jordan elimination, row echelon form(ref), reduced row echelon form(rref).
2 Column vector form of LS. Examples of vector spaces. (spaned) subspace, linear (in)dependence, basis, dimension, coordinates by G-J elimination.
3 Matrix form of LS. Matrix operations, properties, special matrices, power and inverse of a matrix.
4 Linear maps and their matrices. Fundamental subspaces, rank, dimension theorem for matrices. Linear transformations of the euclidean plane, their matrices.
5 Change of bases. Matirx of a linear map in new the new basis. Determinants, computation rules, geometric interpretaion.
6 Eigenvalue problem. characteristic polynom and equation, eigenvalues, eigenvectors, eigenspaces.The case of multiple roots. diagonalizability. Eigenvectors of symmetric matrices
7 Orthogonal projection of a vector to a subspace. Orthogonal complement. Gram-Schmidt ortogonalization. Least squares method.
8 Statistical introduction: population, individual, sample, variable. Exploratory data analysis: graphical representation: pie and bar chart, frequency and density histograms, time plots. Numerical representation: five-number summary: minimum, first quartile, median, third quartile, maximum: boxplot; measure of center and spead: mean, median, mode, variance, standard deviation. Densityfuctions, normal distributions, standard normal distribution. In two variables: scatterplot, direction, strength, shape of relation, outliers. Linear association, correlation.
9 Sample distribution and its variability. Probability: sample space, event, probability measure, calculation rules. Disjoint and independent events, conditional probability law of total probability, Bayes theorem.
10 Random variables (discrete or continuous). Distribution and density functions. Expected value and variance. Jointly distributed random variables, their joint, marginal, conditional distributions. Independence, covariance, correlation.
11 Common distributions and their properties. Law of large numbers, central limit theorem and the fundamental law of statistics.
12 Statistical inferences. Point estimates, confidence intervals, maximum-likelihood method.
13 Hypothesis testing. Common test: z, t, F, Chi^2 tests.

LABORATORY PRACTICE

DETAILED SYLLABUS AND COURSE SCHEDULE

ACADEMIC HOLIDAYS INCLUDED

LECTURE				
week	**Topic**	**Compulsory reading; page number (from … to …)**	**Required tasks (assignments, tests, etc.)**	**Completion date, due date**
1.	Linear systems of equations (LS). Algebraic representation, Gauss-Jordan elimination.			
2.	Linear systems of equations (LS). Vector representation. Vectorspace, subspace, span, linear independence, basis, dimension, coordinates with respect to a basis.			

3.	Linear systems of equations (LS). Matrix representation. Algebra of matrices, powers and inverse of matrices.			
4.	Matrix as linear map. Fundamental subspaces: row, column, null spaces.Rank of a matrix. Dimension theorem for matrices. Linear transformations of the plane: rotation, scaling, reflection, projection onto a subspace (line, plane).			
5.	Change of bases. Matrix of a linear map. Determinants. Properties under rowequivalent operations. Determinant of a product matrix. Determinant as measure of area, volume.			
6.	Eigenvalue problem. characteristic polynom and equation, eigenvalues, eigenvectors, eigenspaces.The case of multiple roots. diagonalizability. Eigenvectors of symmetric matrices			
7.	Euclidean spaces. Inner product, norm, distance of vectors. Orthogonality, orthonormal systems. Gram-Schmidt-ortogonalization. Orthogonal complement. The null and rowspace of a matrix are orthogonal. Least square method		Midterm test 1	
8.	Mathematical statistics. Introduction. Exploratory data analysis: graphical and numerical representation of data sets in one and two variables.			
9.	Autumn break			
10.	Producing data: sampling, experiments. Need for probability concepts. Probability: sample space, event, probability measure, probability rules. Disjoint and independent events, conditional probability law of total probability, Bayes theorem.			
11.	Random variables (discrete or continuous). Distribution and density functions. Expected value and variance. Jointly distributed random variables, their joint, marginal, conditional distributions. Independence, covariance, correlation.			
12.	Common distributions and their properties. Law of large numbers, central limit theorem and the fundamental law of statistics.			
13.	Inferential statistics. Estimates of parameters with points and intervals. Maximum likelihood method. Hypothesis testing. General considerations. The u-, t-, F-, Chi^2-tests.			
14.	Midterm test 2			

PRACTICE, LABORATORY PRACTICE				
week	**Topic**	**Compulsory reading; page number (from … to …)**	**Required tasks (assignments, tests, etc.)**	**Completion date, due date**
1.	Vectorspace, subspace, linear independence, basis, dimension (transition from 3D geometric vectors to coordinatevectors). Vector form of LS.			

2.	Algebraic form of LS. Domain and solution set of LS. (Non-)Homogeneous, (in)consistent LS. Row equivalent operations, Gauss-Jordan elimination, row echelon form(ref), reduced row echelon form(rref).			
3.	Matrix form of LS. Matrix operations, properties, special matrices, power and inverse of a matrix.			
4.	Linear maps and their matrices. Fundamental subspaces, rank, dimension theorem for matrices. Linear transformations of the euclidean plane, their matrices.			
5.	Change of bases. Matirx of a linear map in new the new basis. Determinants, computation rules, geometric interpretaion.			
6.	Eigenvalue problem. characteristic polynom and equation, eigenvalues, eigenvectors, eigenspaces.The case of multiple roots. diagonalizability. Eigenvectors of symmetric matrices			
7.	Orthogonal projection of a vector to a subspace. Orthogonal complement. Gram-Schmidt ortogonalization. Least squares method.		Midterm1	
8.	Statistical introduction: population, individual, sample, variable. Exploratory data analysis: graphical representation: pie and bar chart, frequency and density histograms, time plots. Numerical representation: five-number summary: minimum, first quartile, median, third quartile, maximum: boxplot; measure of center and spead: mean, median, mode, variance, standard deviation. Densityfuctions, normal distributions, standard normal distribution. In two variables: scatterplot, direction, strength, shape of relation, outliers. Linear association, correlation.			
9.	Autumn break			
10.	Sample distribution and its variability. Probability: sample space, event, probability measure, calculation rules. Disjoint and independent events, conditional probability law of total probability, Bayes theorem.			
11.	Random variables (discrete or continuous). Distribution and density functions. Expected value and variance. Jointly distributed random variables, their joint, marginal, conditional distributions. Independence, covariance, correlation.			
12.	Common distributions and their properties. Law of large numbers, central limit theorem and the fundamental law of statistics.			
13.	Statistical inferences. Point estimates, confidence intervals, maximum-likelihood method. Hypothesis testing. Common tests: z, t, F, Chi^2 tests.			
14.	Consultation			

3. ASSESSMENT AND EVALUATION

(Neptun: Instruction/Subjects/Subject Details/Syllabus/Examination and Evaluation System)

ATTENDANCE

In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds 30% of the contact hours stipulated in the course description.

Method for monitoring attendance *(e.g.: attendance sheet / online test/ register, etc.)*

attendance list or online test

ASSESSMENT

Cells of the appropriate type of requirement is to be filled out (course-units resulting in mid-term grade or examination). Cells of the other type can be deleted.

Course resulting in mid-term grade *(PTE TVSz 40§(3))*

Mid-term assessments, performance evaluation and their ratio in the final grade *(The samples in the table to be deleted.)*

Type	Assessment	Ratio in the final grade
Test 1		45%
Test 2		45%
practice class diagnostic tests		10%

All midterm test are compulsory. One can be missed with good reason and must be noted in advance. Each of the tests must be more than 30% (passed). The mid-term grade is calculated from the passed test scores and the diagnostic tests by the weighted average shown in the table above.

Opportunity and procedure for re-takes (PTE TVSz 47§(4))

The specific regulations for improving grades and resitting tests must be read and applied according to the general Code of Studies and Examinations. E.g.: all tests and assessment tasks can be repeated/improved at least once every semester, and the tests and home assignments can be repeated/improved at least once in the first two weeks of the examination period.

The possibly missed test can be retaken in the first exam week. If the student cannot succeed, then – in the second week of examination – both tests must be retaken, and be at least 40% each to pass the course.

Grade calculation as a percentage

based on the aggregate performance according to the following table

Course grade	Performance in %
excellent (5)	85 % …
good (4)	70 % ... 85 %
satisfactory (3)	55 % ... 70 %
pass (2)	40 % ... 55 %
fail (1)	below 40 %

The lower limit given at each grade belongs to that grade.

4. SPECIFIED LITERATURE

In order of relevance. (In Neptun ES: Instruction/Subject/Subject details/Syllabus/Literature)

COMPULSORY READING AND AVAILABILITY

[1.] David S. Moore, The Basic Practice of Statistics, Fourth edition, W. H. Freeman and Company, 2007

[2.] Anthony Hayter, Probability and Statistics for Engineers and Scientists (4. ed.), Brooks/Cole, 2012. (ISBN-13: 978-1-111-82704-5)

RECOMMENDED LITERATURE AND AVAILABILITY

[3.] Moodle and Teams materials