COURSE DESCRIPTION CARD - SYLLABUS

Course name
Multivariate Statistics [S1MNT1>StatW]

Course

Field of study
Mathematics of Modern Technologies

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other
0

Tutorials
15

Projects/seminars
15

Number of credit points

5,00

Coordinators

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Lecturers

Prerequisites

Probability theory, mathematical statistics, matrix algebra, basic skills in R.

Course objective

The aim of the course is to provide students with knowledge of multivariate mathematical statistics, including the theory of estimation and testing hypotheses in multivariate models, principal components analysis and discriminant analysis, and to gain practice in their implementation.

Course-related learning outcomes

Knowledge:
• the student knows and understands to an advanced degree selected branches of mathematics and has detailed knowledge of the applications of mathematical methods and tools in engineering and technical sciences [K_W01(P6S_WG)];
• the student knows and understands the concepts, theorems and methods for mathematical modeling [K_W02(P6S_WG)];
• the student knows and understands issues in computer science, including numerical methods; knows at least one software package or programming language [K_W07(P6S_WG)];

• the student nows and understands to an advanced degree the techniques for making measurements, acquiring, processing and analyzing data or signals [K_W08(P6S_WG)].

Skills:
• the student is able to use the knowledge of higher mathematics [K_U01(P6S_UW)];
• the student is able to build and analyze simple mathematical models [K_U02(P6S_UW)];
• the student is able to formulate an engineering problem, conduct a detailed study using analytical or simulation or experimental methods, interpret the results obtained and draw conclusions [K_U 07(P 6S_U W)];
• the student is able to select the appropriate method and use the measurement apparatus to perform the measurement of basic measurands; is able to use basic methods of data or signal processing and analysis [K_U09(P6S_UW)];
• the student is able to work individually and in a team, as well as cooperating with others; he/she is able to estimate the time needed to complete the commissioned task; he/she is able to develop and implement a work schedule ensuring that the deadline is met [K_U16(P6S_UO)].

Social competences:
• the student is ready to critically evaluate the level of his/her knowledge in relation to the conducted research in science, natural sciences and engineering [K_K01(P6S_KK)];
• the student is ready to deepen and broaden his knowledge to solve newly created technical problems [K_K02(P6S_KK)].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures: exam covering the issues presented on lectures;

Tutorials: test covering the issues presented on classes;

Laboratory classes: test covering the issues presented on labs (with the use of R package)

Project: preparation of a project related to the statistical analysis of multivariate data.

Programme content

• matrix algebra - revisited;
• radnom vectors and their distributions;
• basic statistics and multivariate sampling distributions;
• missing observations problem;
• tests of multivariate normality;
• tests of expectation and covariance matrix;
• multivariate linear models;
• multivariate regression;
• principal component analysis;
• discriminant analysis;
• classification anasysis

Course topics

• matrix algebra - revisited;
- eigenvalues and eigenvectors;
- positive definite matrices;
- partitioned matrices and their properties;
- vector and matrix derivatives;
• radnom vectors and their distributions;
- vector of expectation, covariance matrix, correlation matrix;
- multivariate distributions, including multivariate normal distribution;
- regression and correlation;
• basic statistics and multivariate sampling distributions;
- vector of means, sample covariance matrix;

- discrepancy measures between vectors;
- generalized variance;
- quadratic form distributions;
- wishart distribution and its properties;
- distribution of sample correlation coefficient;
• missing observations problem;
• tests of multivariate normality;
• tests of expectation and covariance matrix;
- test of expectation for known covariance matrix;
- test of expectation for unknown covariance matrix;
- test of expectation equality for two populations;
- sphericity test of covariance matrix;
- test for equality of covariance matrices;
• multivariate linear models;
- one-way models;
- multivariate analysis of variance (MANOVA);
• multivariate regression;
- multiple regression;
- multivariate multiple regression;
• principal component analysis (PCA);
- population and sample principal components;
- methods of principal components selection;
- testing hypotheses related to principal components;
• discriminant analysis;
- linear discriminant function;
- discriminant analysis for two groups case;
- discriminant analysis for several groups case and association measures between discriminant functions;
- tests of significance;
• classification analysis;
- linear and quadratic classification functions;
- classification analysis for two groups case;
- classification analysis for several groups case.

Teaching methods

Lectures: theory presented in connection with the current knowledge of students, presentation of new topic preceded by a reminder of related content, known to students from other subjects;

Tutorials: conducting derivations of certain properties of estimators / tests and solving sample tasks on the board, initiating discussion on solutions of statistical problems;

Laboratory classes: individual and team programming, computational experiments (using R package);

Project: consulting individual topics with students

Bibliography

Basic:
• Krzyśko, M. (2010). Podstawy wielowymiarowego wnioskowania statystycznego. Wydawnictwo Naukowe UAM w Poznaniu;

Additional:
• Anderson, T.W.(2003). An Introduction to Multivariate Statistical Analysis (3 ed). John Wiley & Sons;
• Rencher, A.C. (2002). Methods of Multivariate Analysis. John Wiley & Sons;
• Johnson, R.A., Wichern, D.W. (2007). Applied Multivariate Statistical Analysis. Pearson Prentice Hall.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	77	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	48	2,00