COURSE OF STUDY *International Master degree in Innovation Development In Agrifood Systems (IDEAS) - (LM69)*

ACADEMIC YEAR *2024-2025*

ACADEMIC SUBJECT *Advanced data analysis methods for sustainable agronomic and environmental management (6 ETCS)*

General information	
Year of the course	*First year*
Academic calendar (starting and ending date)	*Second semester (3 March 2025 - 13 June 2025)*
Credits (CFU/ETCS):	6 ETCS
SSD	*Agronomy and crop science - AGRI-02/A (ex AGR/02)*
Language	*English*
Mode of attendance	*Not mandatory but recommended*

Professor/ Lecturer	
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Virtual room	*TEAMS platform: annamaria.stellacci@uniba.it*
Office Hours (and modalities: e.g., by appointment, on line, etc.)	*Tutoring will take place from Monday to Friday by appointments. Tutoring could also take place on e-learning platforms (Teams).*

Work schedule			
Hours			
Total	Lectures	Hands-on (on-class exercises, laboratory, working groups, seminars)	Out-of-class study hours/ Self-study hours
150	*32*	*28*	*90*
CFU/ETCS			
6	*4*	*2*	

Learning Objectives	The course aims to provide knowledge and understanding on: ○ planning of traditional and innovative experimental designs for agronomic research and environmental monitoring and statistical analysis of collected data; ○ interpretation of the results of advanced data analysis methodologies such as the analysis of covariance, the analysis of repeated measures data over time and space, the estimation of crop and soil variables through advanced statistical methods (multivariate and machine learning methods) in order to ensure a sustainable management of agronomic techniques and an efficient use of natural resources.
Course prerequisites	Basic knowledge on descriptive and inferential statistics.

Teaching strategies	Learning activities will consist in theoretical lectures and applied activities

	including exercises on statistical procedures studied, study case analysis, seminars and lessons from experts in the studied disciplines.
Expected learning outcomes in terms of	
Knowledge and understanding on:	Expected learning outcomes, as knowledge and ability, are reported in the Didactic Regulation of the course in IDEAS (expressed by European Descriptors). ○ Knowledge of the principles of planning and analysis of data collected from traditional and innovative experimental designs for agronomic and environmental research. ○ Basic knowledge of advanced data analysis methodologies such as analysis of covariance and statistical methods for the analysis of repeated measures data over time and space. ○ Through the case study approach, understanding the meaning, the potentiality and the results interpretation of complex data analysis methods to ensure a sustainable management of agronomic techniques and an efficient use of natural resources (estimation of crop and soil variables through machine learning methods, geostatistics and data interpolation, etc.).
Applying knowledge and understanding on:	○ Ability to plan an experimental design for research in agriculture; ability to apply the methodologies studied; ability to understand and interpret the results of more complex data analysis techniques.
Soft skills	• *Making informed judgments and choices* ○ Ability to select the most appropriate methodologies for planning an experimental design, analysing the data collected and understanding the results obtained. • *Communicating knowledge and understanding* ○ Ability to present the results of the research activity; ○ Ability to transfer the theoretical and applied knowledge acquired from the scientific world to the agrifood sector. • *Capacities to continue learning* ○ Ability to further deepen advanced techniques for data analysis (analysis of spatial and temporal data; multivariate data analysis and use of machine learning approaches; planning of more complex hierarchical designs).
Syllabus	
Content knowledge	Students will acquire theoretical and applied knowledge with regard to: •planning and analysis of data collected from traditional and innovative experimental designs for agronomic research and environmental monitoring; •main univariate and bivariate parametric data analysis techniques; •analysis of covariance and its role and potentiality in agronomic and environmental research; •basic knowledge on assessment of temporal and spatial variability of observations and residuals. In addition, through the analysis of case studies, the students will understand the meaning, the potentiality and the results interpretation of complex data analysis methods to ensure a sustainable management of agronomic techniques and an efficient use of natural resources (estimation of crop and soil variables through machine learning methods, geostatistics and data interpolation, etc.). Contents: Recall of traditional methods of data analysis (test of hypothesis; test of the assumptions for the application of parametric data analysis methods; basic

	concepts of main parametric methods for univariate and bivariate analysis). Planning and analysis of data collected from traditional and innovative experimental designs for single-factor and factorial experiments in non-hierarchical and hierarchical experimental designs. Analysis of covariance and use of auxiliary information, deriving also from proximal sensors, to improve the estimation of soil and crop variables. Basic understanding of statistical methods for the analysis of repeated measures data in time and space (different approaches, modeling the covariance structure of the residuals). Basic knowledge of linear mixed effects models taking into account temporal and spatial correlation of soil and crop properties. Analysis and discussion of case studies will focus on: analysis of long-term field experiments (LTEs) data; identification of management zones (MZ) for agro-environmental applications (precision application of water and nutrient inputs); collection and analysis of proximal sensing information to estimate soil (TOC, SWC) and crop properties.
Texts and readings	Lecture notes and teaching material made available during the course. • Littell R.C., Milliken G.A., Stroup W.W., Wolfinger R.D., Schabenberger O., 2006. SAS for Mixed Models, Second Edition. Cary, NC: SAS Institute Inc. • Gomez K.A., Gomez A.A., 1984. Statistical procedures in agricultural research. New York, Chichester, etc.: Wiley, 2nd edition. • Quinn G.P., Keough M.J., 2002. Experimental Design and Data Analysis for Biologists. Cambridge. • France J., Thornley J.H.M., 1984. Mathematical Models in agriculture. Butterworths, London. • Camussi et al., 1995. Metodi Statistici Per la Sperimentazione Biologica. Zanichelli Bologna.
Notes, additional materials	Additional readings • Scientific papers provided by the teacher. Further material will be provided by the teacher on request.
Repository – Didactic materials	The teaching material presented during the lessons (power point lessons, texts, book chapters, publications) will be made available on the Teams platform. The power point of the lessons cannot be used as study material but as a support to the use of the suggested textbooks chapters and other teaching material provided.

Assessment	
Assessment methods	The final exam consists of a written exam and an oral exam. The written exam could be divided into two parts and will be focused: i) on the analysis of variance of data from a factorial experiment (under a hierarchical or non-hierarchical experimental design) and ii) on the analysis of covariance; in addition, questions on randomization and layout of the main experimental designs studied will be included. The first part of the written exam could be carried out as intermediary exam (*esonero*). The oral exam will be focused on questions related to the lectures, exercises and laboratory classes. The evaluation of the student is based on criteria previously fixed as reported in the Academic Regulations for the Master Degree in Innovation Development in Agrifood Systems and in the study plan.
Assessment criteria	• *Knowledge and understanding* ○ The student is able to plan traditional or innovative experimental designs and apply appropriate statistical data analysis methods.

	○ The student is able to understand and use the main methodologies studied for data analysis (analysis of covariance; statistical methods for the analysis of repeated measures data). • *Applying knowledge and understanding* ○ Ability to apply the acquired knowledge to solve case studies. • *Making informed judgements and choices* ○ Ability to select the most appropriate methodologies and correctly interpret the results of the statistics tests studied. • *Communicating knowledge and understanding* ○ Ability to present the results of the research activity. • *Communication skills* ○ Ability to organize the acquired knowledge in form of didactic presentation and to articulate it for didactic purposes. ○ Ability to transfer the theoretical and applied knowledge acquired from the scientific world to the agrifood sector. • *Capacities to continue learning* ○ Ability to further deepen advanced techniques for data analysis (analysis of spatial and temporal data; multivariate analysis and use of machine learning methods; planning of complex hierarchical designs).
Final exam and grading criteria	The final score is within 18/30 to 30/30. The exam is considered passed if a final score of at least 18/30 is reached.
Further information	