**APPLIED STATISTICS AND PHYSICS**

## Prof. Umberto Catellani - Prof. Licia Colli

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The Physics module aims to provide the students with the rudiments, necessary for learning Physics, with the use of logic, algebra, trigonometry, and through the solution of problems and real case-studies. The overall goal of the statistic module is to provide students a set of essential tools and methods to explore their data, understand and solve problems related to data handling and analysis, formulate a hypothesis and make decisions on the base of the results obtained.

By the end of the course, the students will:

* be able to analyse, discuss and solve simple physics problems and will also gain a scientific point of view on the aspects of everyday life connected with the topics covered;
* acquire a practical understanding of the statistical methods applied to agri-food data and the ability to gather, analyse and interpret relevant data within their field of study
* to develop analytical skills towards problems to approach them from a rational and scientific point of view.
* communicate in oral and written forms about their understanding and deliver a correct analysis of a problem using suitable and proper technical language to both specialist and non- specialist audiences.

During the course, students are fostered to challenge themselves with problems submitted between lessons to tackle future issues and insufficient understanding of the topics covered during lessons. The submitted problems also constitute a benchmark test to assess the achieved level.

Regardless of previous background, at the end of the course, the student will have to hold learning capacities suitable to either lead him/her to higher study courses.

***COURSE CONTENT Physics***

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|  |  | CFU |
| 1 | Review of Mathematical tools for physics: vector and scalar quantities, trigonometry’s basics, Cartesian plane vector analysis. | 0.2 |
| 2 | Kinematics: One-dimensional motion (uniform motion, uniformly accelerated motion and free-fall motion). Two-dimensional motion: simple projectile motion, uniform circular motion. Equation and graphical models. | 0.5 |
| 3 | Dynamics: Types of forces and their scales of significant impact. Newton’s Laws of Motion. Extensive application and problem solving. Sources of forces – tension, friction, and springs and Hooke’s Law. | 1 |
| 4 | Linear Momentum: Impulse, Linear Momentum, Conservation of Linear Momentum, Inelastic and Elastic collisions | 0.5 |
| 5 | Work, Energy, and Conservation of Energy: Definition of Work, Positive and negative work, work of constant and variable forces, Energy, Mechanical Energy, Discussing other types of energy in the world, Conservation of energy, Criteria for mechanical energy to be conserved, Power. | 1 |
| 6 | Fluids: Properties of fluids—gases and liquids, Hydrostatic Pressure & Pascal’s Principle, Buoyancy (Archimedes’ Principle), Fluid Flow Continuity (Conservation of Mass), Bernoulli’s Equation. | 0.4 |
| 7 | Thermodynamics: Temperature, Pressure, Heat/Energy Transfer, Thermal Capacity, Heat Equation, Melting, Boiling, Vaporization, Evaporation, Ideal Gases & Gas Laws, Kinetic-Molecular Theory (KMT), Laws of Thermodynamics | 0.4 |
|  | Practical Exercises: problems and guided exercises on all the topics | 1 |

***COURSE CONTENT Applied Statistics***

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|  |  | CFU |
| 1 | The Role of Statistics and Data Analysis in Agri-food production. Numerical Methods for Describing Data. How to describe data by summary statistics: measures of central tendency and variability. | 0.25 |
| 2 | Graphical Methods for Describing Data. How to describe agri-food data graphically for categorical data (pie chart, bar chart) and graphs for quantitative variables (histogram, stem-and-leaf plot, time plot, etc).  | 0.25 |
| 3 | Introduction to Probability and Distributions. How binomial distributions and normal distributions are involved in statistics. | 0.75 |
| 4 | Hypothesis Testing. How to set up Null and Alternative hypotheses, understanding Type I and Type II errors, performing a statistical test for the population mean. How to calculate confidence intervals.  | 1 |
| 5 | Comparing Populations or Treatments. How to compute the power of a test and choose the sample size for testing population mean, how to compare the mean of two populations for independent samples, how to compute and interpret P values, how to use contingency tables and the Chi-square test. Introduction to the Analysis of Variance. | 0.75 |
|  | Exercise section: problems and guided exercises on the course topics. Introduction to Excel software. | 1 |

***READINGS LIST:***

Roger Freedman, Todd Ruskell, Philip R. Kesten, David L. tauck

*College Physics* (Second Edition), Macmillan Education

Ron Larson, Elizabeth Farber

*Elementary Statistics: Picturing the World* **–** Prentice Hall A Division of Pearson Education
Upper Saddle River, NJ 07458

Further material will be made available either during the lessons or on Blackboard platform during the course, including the slides used during the lessons and other complementary monographic materials on specific topics. Such materials will be made available s during the course.

***TEACHING METHOD***

The course will consist of classroom lectures given to convey the basic principles of physics and statistics. The course will also demonstrate to students how to solve problems applying the fundamental laws of physics and the basic statistics tools, with an emphasis on situations students will encounter in their everyday life and to provide students a set of statistical toolboxes and practical examples to be applied on agri-food data.

A series of exercises solved step by step will provide the students with examples useful to apply the theoretical concepts acquired.

Real cases and examples from the agri-food sector will be illustrated and discussed during the lessons to promote the application of knowledge and the practical understanding of the basic concept.

A series of drills complementing the theoretical front-end lesson will be provided to reinforce the concepts and to improve the student skills on procedures. During the drills, practical exercises will be submitted to the class and solved with the support of the instructors.

***ASSESSMENT METHOD AND CRITERIA***

Physics and Statistics modules: Written test (total maximum score is 16) on the whole syllabus and eventually followed by an oral interview. The test will include a series of exercises of different levels of difficulty (expressed by an integer value). The final mark for each module (out of 16 points) will be obtained by summing up of the value of the exercises done correctly. The students will be given 1 hour per module to complete the test. Students reaching a score of 9 or more can accept the score directly without taking the oral exam. Students who want to improve the mark can take the oral exam the same day of the written test or in the following days. Also students who reached a score of at least 8 in the written test can attempt the oral exam *sub judice*. The final evaluation is calculated as the average between the scores of the written tests and the oral exam.

The oral interviews will consist of open questions and of the solution of a few exercises. The interview evaluation will be based on: a) the actual knowledge of the subject and the overall handling of the matter; b) use of proper terms and clearness of exposition during the interview; c) ability to make connections between different topics and subjects.

The course will be considered achieved if the student scores at least 9 in both modules on the same exam session. The final score is the sum of the partial scores achieved in the Physics and in Statistics modules.

***NOTES AND PREREQUISITES***

To properly follow the course, the audience should master the following topics: algebraic manipulation of formulas, first and second-degree equations and inequalities, straight lines and parabolas equations and their representation on a Cartesian plane, basics of vector algebra, trigonometry. The course will not cover these topics.

## Prof. Umberto Catellani

Office hours for students: by appointment.

## Prof. Licia Colli is available to meet students by appointment at the Department of Animal Science, Food and Nutrition (DIANA).

In case the current Covid-19 health emergency does not allow frontal teaching, remote teaching will be carried out through synchronous or asynchronous procedures that will be promptly notified to students.