UNIVERSITÀ CATTOLICA del Sacro Cuore

Applied Statistics And Physics

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Course aims and intended learning outcomes

The course 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. By the end of the course, the students will be able to analyse, discuss and solve simple physics problems. Moreover students will develop analytical skills towards problems, in order to approach them from a rational and scientific point of view.

The overall goal of the course in applied statistics is to provide the participants a set of basic tools and methods to explore their data, understand and solve problems related to data handling and analysis, formulate judgment or taking decisions on the base of the results obtained. The basic course will provide instruction to distinguish between different types of data, assess which methods for summarising a data set are most appropriate to highlight interesting features, identify the features that describe a data distribution, identify and use the most appropriate methods for data summary and exploratory analysis as well as detect possible sources of bias and confounding in experiments and surveys.

From the active participation of both physics and statistics modules, including the drills, it is expected that the students will:

- acquire a conceptual and practical understanding of the application of the methods learned to agri-food data
- apply their knowledge and understanding in other contexts;
- have the ability to identify and use data to formulate responses to well-defined concrete and abstract problems;
- communicate about their understanding, skills and activities, to both specialist and non- specialist audiences with appropriate terminology;
- have the ability to gather, analyze and interpret relevant data within their field of study
- have developed learning skills to undertake further studies on statistics and physics with some autonomy.

Course content

Physics

		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	1

	other types of energy in the world, Conservation of energy, Criteria for mechanical energy to be conserved, Power.	
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, with specific focus on Kinematics, Dynamics and	1

Applied Statistics

		CFU
1	The Role of Statistics and Data Analysis in Agri-food production	0.25
2	Numerical Methods for Describing Data. How to describe data by summary statistics: measures of central tendency and variability	0.50
3	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
4	Introduction to Probability and Distributions How binomial distributions and normal distributions are involved in statistics.	1
6	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.	1
7	Comparing Populations or Treatments. How to compute power of a test and choosing the sample size for testing population mean; How to compare the mean of two populations for independent samples, how to compute and interpret P value, How to use contingency table and the Chi-square test	1

Reading list

DOUGLAS GIANCOLI, *Physics: Principles with Applications* (Global Edition), Pearson Higher Ed USA 2016.
Ebook format available.

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 during the course, including the slides used during the lessons and other complementary monographic materials on specific topics. Such materials will be made available in blackboard platforms during the course.

Teaching method

The course will consist of lectures given by the instructors to convey the basic principles of physics and statistics. The course will also involve demonstrating to students how the basic laws of physics can be used to solve problems, with an emphasis on situations students will encounter in their everyday lives and to provide students a set of statistical toolboxes and practical examples to be applied in agri-food.

A series of exercises solved step by step collegially will provide the students with a set of examples useful to apply the theoretical concept acquired.

Real cases and examples from agribusiness sectors will be illustrated and discussed during the lessons to promote the applying knowledge and practical understanding of the basic concept.

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

Assessment method and criteria

Physics: Written test on the whole syllabus. Test is split into multiple choice tests and open answer problems.

Final mark (out of 30 points) will be obtained in proportion to the percentage of properly answered questions and properly solved problems.

Statistics: Written test on the topics covered by the course. Written test includes a series of exercises of different level of difficulty expressed by an integer value.

Final mark (out of 30 points) will be built summing up the value of the exercises done correctly.

The course will be considered achieved if the student scores 18 in both the modules at least. The final score is the mathematical average of the partial scores achieved in the physics module and in statistics module.

Notes and prerequisites

To properly follow the course, the audience should masters the following topics: algebraic manipulation of formulas, first and second degree equations and inequalities, straight lines and parabolas equations and their representation on Cartesian plane, basics of vector algebra, trigonometry. These topics will not be covered during the course.

Prof. Umberto Catellani - Office hours for students: every Thursday 11 to 12.30 by appointment.

Prof. Riccardo Negrini - Office hours for students: every Monday 11 to 12.30 by appointment