Medicine and Surgery degree course
Teaching: Physics and Statistics 12 CFU
SSD: FIS/07; INF/01; MED/01
Course Coordinator: Domenico Rocco

Teaching module: Applied Physics
SSD: FIS/07
Number of CFUs: 5
Prof. Gian Marco Contessa (2 CFU) e-mail: gianmarcocontessa@unicamillus.org
https://www.unicamillus.org/personnel/contessa-gianmarco-2/
Prof. Paolo Calligari (1.5 CFU) e-mail:
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Prof. Marco D'Arienzo (1.5 CFU) e-mail:
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Teaching module: Informatics
SSD: INF/01 Computer Science
Number of CFUs: 3
Prof. Domenico Rocco (1 CFU) e-mail: domenico.rocco@unicamillus.org
https://www.unicamillus.org/personnel/rocco-domenico/
Prof. Franco Arcieri (2 CFU) e-mail: franco.arcieri@unicamillus.org

Teaching module: Medical Statistics
SSD: MED/01
Number of CFU: 4
Prof. Monica Sane Schepisi (1 CFU) e-mail:
monica.saneschepisi@unicamillus.org
https://www.unicamillus.org/personnel/sane-schepisi-monica-2/
Prof. Francesco Bartolozzi (1 CFU) e-mail:
francesco.bartolozzi@unicamillus.org
https://www.unicamillus.org/it/personnel/bartolozzi-francesco/
Prof. Luca Paolo Weltert (2 CFU) e-mail: luca.weltert@unicamillus.org
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PREREQUISITES

Knowledge and skills in basic mathematics, statistics and computer science at secondary school level, including arithmetic, algebra, Euclidean geometry, trigonometry and elements of differential and integral calculus. However, teaching does not include propaedeutics.

LEARNING OBJECTIVES

The aim of the integrated Physics and Statistics course (Applied Physics, Medical Statistics and Computer Science) is to provide students with the knowledge of the fundamentals of applied physics, computer science and statistics necessary for their future work. In particular, an

understanding of the physical principles underlying medical physics and the functioning of medical instrumentation will be addressed.
At the end of the module, students will know the fundamental concepts of the application of the Scientific Method to the study of biomedical phenomena (choice and measurement of parameters, evaluation of errors), they will be able to describe the physical phenomena of complex systems

using appropriate mathematical tools, they will know the scientific basis of medical procedures and the operating principles of equipment commonly used for diagnostics and therapy.
Students should understand the computer tools and concepts that will be useful to them in their future profession in the medical field. It is an essential objective of the Medical Statistics course to learn the knowledge of the essential elements of medical statistics, which include: parameters for descriptive analysis (mean, median, fashion and frequency measures of the distribution of categorical variables), parameters for the analysis of variability (variance, standard deviation and confidence intervals) and elements of inferential statistics (use and interpretation of the most common statistical tests), and regression techniques. Students must be able to: understand the importance of medical statistics in medical research methodology; read a basic biomedical scientific article, understanding its structure and critically evaluating its methods and results; handle a simple database, with particular reference to clinical medicine; carry out descriptive and inferential analysis.

OBIETTIVI FORMATIVI/ LEARNING OUTCOMES

The expected learning outcomes are consistent with the general provisions of the Bologna Process and the specific provisions of Directive 2005/36 / EC. They are found within the European Qualifications Framework (Dublin descriptors) as follows:

1. Knowledge and understanding

- To have understood the experimental method and to have acquired rigour in the use and transformations of units of measurement;
- To know and correctly understand the terminology of physics, statistics and computer science.
- Know the fundamental principles and laws of physics concerning kinematics, dynamics, electricity and magnetism, vibrations and waves, radiation, nuclear physics and fluids.
- Apply these concepts to biological and physiological phenomena in living organisms.
- Identify and recognise the physical principles governing the function of specific human organs.
- Know the basics of an information system in a healthcare facility. Furthermore, he/she must know how a database is organised and must know some basics of database query languages. He/she must know the security and privacy issues associated with the management of sensitive and non-sensitive data such as health data. They must know the problems associated with reading data from electronic instruments, units of measurement, standards, errors.
- Perform a descriptive analysis of a simple database; know and apply frequency and effect measures;
- Demonstrate an understanding of probability and its application;
- Demonstrate ability to handle data and to draw and present quantitative results effectively, using appropriate tables, figures and summaries;
- Evaluate the association between variables;
- Describe the nature of sampling variation and the role of statistical methods in quantifying it, and be able to calculate confidence limits and evaluate assumptions;
- Select and use appropriate statistical methods in the analysis of simple data sets;
- Understand the concepts of confounding and effect modification;
- Select and use appropriate statistical methods in the analysis of simple data sets;
- Know the basic principles of correlation and linear regression analysis;

- Know introductory elements of survival analysis, multiple linear regression, logistic regression, Cox and Poisson regression analyses;
- Explain how statistical inference is applied biomedical research;
- Describe the general principles of power sample size calculation;
- Interpret and evaluate the results of statistical analyses within a scientific publication; Present and discuss the results of statistical analyses in a clear, concise and understandable manner.

EXPECTED LEARNING OUTCOMES

Applying knowledge and understanding

- Apply the principles of physics, computer science and statistics to selected problems and a variable range of situations.
- Use the tools, methodologies, language and conventions of physics, computer science and statistics to test and communicate ideas and explanations

Communication skills

- Explain arguments in an organised and coherent manner.
- Use scientific language appropriately and in accordance with the topic of discussion.

Making judgements

- Recognise the importance of in-depth knowledge of topics in accordance with appropriate medical education.
- Identify the fundamental role of correct theoretical knowledge of the subject in clinical practice.

PROGRAMMA/COURSE SYLLABUS

PHYSICS PROGRAMME

Syllabus Prof. GM Contessa:

Introduction, Measurement, Estimating
Measurement and Uncertainty; Significant Figures
Units, Standards, and SI Units
Converting Units
Dimensions and Dimensional Analysis
Vectors and Scalars

Vectors
Addition of Vectors-Graphical Methods
Subtraction of Vectors and Multiplication of a Vector by a Scalar
Adding Vectors by Components
Scalar and Vector Products

Describing Motion: Kinematics

References Frames and Displacement
Average Velocity
Instantaneous Velocity
Acceleration
Motion at Constant Acceleration
Kinematics of Uniform Circular Motion
Nonuniform Circular Motion

Dynamics:
Newton's Laws of Motion
Force
Newton's First Law of Motion
Mass
Newton's Second Law of Motion
Newton's Third Law of Motion
Weight-The Force of Gravity;
The Normal Force
Friction
Elasticity and Hooke's Law
Circular Motion; Gravitation
Dynamics of Uniform Circular Motion
Newton's Law of Universal Gravitation Types of Forces in Nature

Work and Energy
Work Done by a Constant Force
Kinetic Energy and the Work-Energy Principle
Potential Energy (gravitational potential energy, potential energy of elastic spring)
Conservative and Nonconservative Forces
Mechanical Energy and its Conservation
Problem Solving Using Conservation of Mechanical Energy
Other Forms of Energy: Energy Transformations and the Law of Conservation of Energy
Power

Linear Momentum
Momentum and its Relation to Force
Conservation of Momentum
Center of Mass
Center of Mass and Translational Motion

Rotational Motion Angular Quantities Torque

Static Equilibrium
The Conditions for Equilibrium
Applications to Muscles and Joints
Stability and Balance
Elasticity
Stress and Strain

Fracture

Fluids
Phases of Matter
Density
Pressure in Fluids
Atmospheric Pressure; Gauge Pressure
Pascal's Principle
Buoyancy and Archimedes' Principle
Fluids in Motion;
Flow Rate and the Equation of Continuity
Bernoulli's Principle
Applications of Bernoulli's Principle: stenosis, aneurism and TIA
Viscosity
Flow in Tubes: Poiseuille's Equation, High blood pressure
Pumps, and the Heart

Temperature
Atomic Theory of Matter
Temperature and Thermometers
Thermal Equilibrium
Thermal Expansion

Heat
Heat as Energy
Transfer Internal
Energy Specific Heat
Calorimetry
Heat Transfer:
Conduction Heat
Transfer: Convection Heat
Transfer: Radiation

The Laws of Thermodynamics
The First Law of Thermodynamics
Human Metabolism and the First Law
Second Law of Thermodynamics-Introduction
Entropy and the Second Law of Thermodynamics
Order to Disorder

Electric Charge and Electric Field
Static Electricity
Insulators and Conductors
Induced Charge
Coulomb's Law
The Electric Field

Electric Potential
Electric Potential Energy

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Electric Potential Due to Point Charges

Capacitance
Dielectrics

Electric Currents
The Electric Current
Ohm's Law: Resistance and Resistors
Electric Power
Microscopic View of Electric Current
Electrical Conduction in the Human Nervous System

DC Circuits
EMF and Terminal Voltage
Resistors in Series and in Parallel
Kirchhoff's Rules
RC Circuits

Magnetism
Magnets and Magnetic Fields
Electric Current and Magnetic Fields
Ampere's Law

Electromagnetic Induction and Faraday's Law
Induced EMF
Faraday's Law of Induction; Lenz's Law
EMF Induced in a Moving Conductor
Changing Magnetic Flux Produces an Electric Field

Vibrations and Waves
Wave Motion
Types of Waves: Transverse and Longitudinal
Reflection and Transmission of waves
Interference; Principle of Superposition
Standing Waves; Resonance
Characteristics of Sound
The Ear and Its Response
Doppler Effect
Applications: Ultrasound and Medical Imaging

Electromagnetic Waves
Production of Electromagnetic Waves
Light as an Electromagnetic Wave and the Electromagnetic Spectrum
Energy in EM Waves

The Wave Nature of Light
The Visible Spectrum and Dispersion

Optical Instruments
The Human Eye; Corrective Lenses
Resolution of the Human Eye and Useful Magnification

Radiation in Healthcare
Electromagnetic radiation
ionizing and non-ionizing radiation
Medical uses for radiation (diagnostics and in therapy)

Ionizing radiation in medicine
X-Ray Medical Imaging
Physical principles and technical aspects of diagnostics x-ray devices
Computed Tomography (CT)
Single Photon Emitting Tomography (SPECT)
C-arm systems and other x-ray equipment

Non-ionizing radiation:
Magnetic Resonance Imaging (MRI)

Radiation protection
Interaction of radiation with cells and tissues
Radiobiology

INFORMATICS PROGRAMME

- Binary system and information codification, input and output, boolean operators.
- Computer architecture, CPU, memories;
- Software: operating systems, application software;
- Word processor (Microsoft Word), including bibliography, citations and references;
- Spreadsheet (Microsoft excel);
- Computer networks, Internet, e-mail, World Wide Web;
- Databases, Academic databases and search engines. Public health databases
- Introduction to health information systems. The Italian health information system. Health standards for data acquisition, storing and visualization. The electronic medical record.
- Information security and Privacy in the management of healthcare data.
- Digital devices, sensors and mobile app for precise medicine. Supporting systems for the physicians.
- Analog to digital conversion

STATISTICS PROGRAMME
- Introduction to biomedical statistics
- Data types, evaluation and presentation
- Probability: evaluation and the role of probability
- Normal distribution, sampling techniques
- Principles of statistical inference
- Inference from a sample mean, comparison of two means; inference from a sample proportion, comparison of two proportions
- The hypothesis testing system, the chi-square test
- Correlation
- Linear regression
- Non-parametric methods
- Introduction to sample size calculation

- Evaluation of diagnostic tests, reproducibility of measurements
- Cohort studies
- Introduction to survival analysis
- Case-control studies
- Probability
- Introduction to multivariate regression
- Introduction to logistic regression
- Introduction to Poisson and Cox regression
- Analysis strategies

COURSE GRADE DETERMINATION

The examination of the Integrated Teaching of PHYSICS, STATISTICS and INFORMATICS consists of a comprehensive assessment test.
During the written test, the Board of Examiners will assess the student's ability to apply the knowledge and will ensure that the skills are adequate to achieve the objectives. The following will also be assessed: autonomy of judgement, communication skills and learning ability according to the Dublin descriptors.

EVALUATION TEST: Student preparedness will be assessed through a written exam. Some questions may carry different weights (scores) based on their complexity. Questions may be multiple-choice, open-ended, or require problem-solving or exercises. The evaluation for each course will be graded on a scale of thirty. The calculated grade for the integrated course will be the result of a weighted average that takes into account the credit value of each course within the integrated program.

The examination will be assessed overall according to the following criteria:

Not sufficient: significant deficiencies and/or inaccuracies in knowledge and understanding of the topics; limited ability to analyse and synthesise, frequent generalisations.

18-20: barely sufficient knowledge and understanding of the topics with possible imperfections; sufficient ability to analyse, synthesise and make independent judgements.

21-23: routine knowledge and understanding of the topics; correct analysis and synthesis skills with coherent logical argumentation.

24-26: fair knowledge and understanding of the topics; good analytical and synthetic skills with rigorously expressed arguments.

27-29: comprehensive knowledge and understanding of the topics; considerable ability to analyse, synthesise. Good autonomy of judgement.

30-30L: very good knowledge and understanding of topics. Remarkable ability to analyse and synthesise and independent judgement. Arguments expressed in an original manner

SUPPORT ACTIVITIES

In addition to the teaching activity, the student will be given the opportunity to deepen the topics covered by attending seminars and by suggesting additional readings of articles and book chapters. The topics of the A.D.E. do not constitute examination subjects. The acquisition of the hours allocated to the A.D.E. only takes place with a compulsory attendance of 100%.

RECOMMENDED BOOKS AND REFERENCES

PHYSICS:

Douglas C. Giancoli "PHYSICS: Principles with Applications" Seventh edition or subsequent, Pearson Education. Inc

The indicated textbook is just a reference. Students are allowed to adopt the book/books of their choice. Additional material will be provided by the instructor.

INFORMATICS:

Lesson slides

Hardy, Lynda R, "Health informatics. An interprofessional approach";

Joos, D. Wolf, R. Nelson, "Introduction to Computers for Healthcare Professionals" seventh edition, 2019, Jones & Bartlett Learning, ISBN 978-1284194708;

Kathleen Mastrian, Dee McGonigle - Informatics for Health Professionals. Jones & Bartlett Learning; 1 edition (April 25, 2016);

Joseph Tan - E-Health Care Information Systems: An Introduction for Students and Professionals. Jossey-Bass Inc Pub; 1 edizione (1 maggio 2012)

The indicated textbooks are just a reference.

STATISTICS:

Lesson slides

Essential Medical Statistics (Kirkwood, Sterne)

The indicated textbook is just a reference. Students are allowed to adopt the book/books of their choice. Additional material will be provided by the instructor.