

## Degree Course in Biomedical Laboratory Techniques

### Integrated teaching: Mathematical, physical and computer sciences

SSD: MEDS-24/A, PHYS-06/A, INFO-01/A

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Number of total credits: 8

### Module: Medical Statistics

SSD: MEDS-24/A

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Number of credits of the single module: 3

### Module: Medical Physics

SSD: PHYS-06/A

Teacher Name: [Maria Giovanna Guerrisi](mailto:mariagiovanna.guerrisi@unicamillus.org)

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Number of credits of the single module: 3

### Module: Computer Science

SSD: INFO-01/A

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Number of credits of the single module: 2

## PREREQUISITES

Knowledge of basic mathematics at secondary school level.

## EDUCATIONAL OBJECTIVES

The aim of the integrated course of Mathematical, Physical and Computer Sciences is to provide students with the knowledge of the fundamentals of applied statistics, computer science and medical physics necessary for carrying out their future activity.

At the end of the course, students will know the fundamental concepts of application of the scientific method to the study of biomedical phenomena (choice and measurement of parameters, evaluation of errors), they will know the operating principles of the equipment commonly used for laboratory diagnostics, will have acquired the knowledge relating to the structure of computers and their language, and the skills necessary to use the most widespread application software and to understand the key role that Information Technology (IT) plays for current society and, in particular, in the field of technical-healthcare professions, will have acquired the knowledge relating to the foundations of medical statistics, the methodology of scientific research and the skills necessary for the use of the most appropriate tests for analyzes in the technical-healthcare field.

## EXPECTED LEARNING OUTCOMES

The expected learning outcomes shall be 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:

### Knowledge and understanding:

The student will acquire the fundamental principles of Physics, Statistics and Computer Science necessary to know and understand the functioning of the "man" machine and the modern instruments and technologies used in medical diagnostics of specific interest of the Degree Course.

At the end of this integrated course the student will be able to:

- Build and interpret graphs.
- Describe the differences between descriptive and inferential (inductive) statistics.
- Calculate the most common indices of central trend and variability of data.
- Analyze frequency distribution curves.
- Carry out a critical reading of articles related to topics with significant content.
- Express themselves with communication skills with technical language of medical statistics.
- Know and understand the experimental method having also acquired the rigor in the use of units of measurement.
- Know and understand correctly the terminology of physics.
- Know the fundamental principles and laws of physics concerning mechanics, calorimetry, electricity and magnetism, radiation, fluids, atomic and nuclear physics and radioactivity.
- Know and understand the laws of physics underlying biological and physiological phenomena in the human body.
- Know and understand the physical principles underlying the instrumentation used in laboratory diagnostics and diagnostic imaging.
- Explain what a Computer is and what its evolution has been.
- Describe the characteristics of modern IT systems.
- Describe the main hardware components of IT systems.
- Describe and use the most common coding systems in computer science.
- Know the difference between system software and application software.
- Know and know how to use the main application software.
- Know the social impact of computers and IT technologies.

### **Ability to apply knowledge and understanding**

At the end of the integrated course the student will be able to:

- Apply the acquired knowledge for the autonomous deepening of specific problems in the context of his future professional activity.
- Apply the methodologies of medical statistics for the study, understanding and explanation of processes.
- Apply the principles of physics to selected problems and a variable range of situations.
- Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.
- Correctly use IT tools in the technical-health field, of which he has become familiar.

### **Communication skills**

At the end of the course the student will be able to understand and use the correct terminology for the description and discussion of topics that require specific skills in the disciplines of integrated teaching.

### **Autonomy of judgment**

At the end of the course the student will be able to evaluate and compare different types of hardware and software of IT systems, the statistical appropriateness of statistical analysis of data in the literature, the experimental procedures and the different instruments commonly used in Biomedical Laboratories.

## Learning ability

The student will have acquired skills and learning methods suitable for deepening and improving their skills in the disciplines of integrated teaching and their specific applications in the technical-health professional field.

## PROGRAM

### Medical Statistics

Introduction to statistics and its application in Biomedical Sciences; purposes and methods of statistical analysis; sampling; data sources; stages of a statistical investigation.

Exploratory data analysis: types of data; statistical universe/sample/frequencies; parameters, estimates, variables, graphical representation of data and use of graphs; measures of central position and dispersion index.

Probability: basics; sum rule and product rule; conditional probability and Bayes' theorem; probability distribution; binomial probability distribution; the Poisson distribution; the standard normal distribution; applications of the normal distribution; sample distributions and estimators; the central limit theorem.

Parameter estimation: estimating the proportion of a population; estimating the mean of a population; estimating the standard deviation (or variance) of a population.

Hypothesis testing with a sample: hypothesis testing; hypothesis testing by proportion; hypothesis testing on the mean; hypothesis testing on standard deviation or variance.

Inference from two samples: inference on two proportions; inference on two means: independent samples; inference on two means: paired samples.

Correlation and regression, prediction intervals and variability; mention of multiple regression.

### Medical Physics

**Physical quantities:** Definition of physical quantity. Fundamental quantities and derivatives. Scalar and vector quantities. Operations with carriers. Systems of units of measurement. Dimensionless quantities. Measurement of physical quantities. Systematic errors and random errors. Sensitivity, precision, readiness and range of an instrument.

**Movement:** Speed and acceleration.

**Forces:** The concept of force and the principle of inertia. The concept of mass and the second law of dynamics. The weight force and the acceleration of gravity. The third law of dynamics. Static equilibrium of a material point. Normal strength. Friction. Rigid bodies and center of gravity. Moment of a force with respect to a point. Balance of a rigid body. Definition and equilibrium condition of a lever. Various types of leverage. Levers in the human body.

**Work and energy:** Work of a force. The kinetic energy theorem. The concept of energy. Conservative forces (outline). Potential energy. Power

**Liquids:** Density and specific gravity. Pressure. Pascal's law. Stevin's law. Unit of measurement of pressure. Pressure gauges. Pascal's law

**Thermometry and gas:** The concept of temperature. The centigrade scale. Clinical thermometer. Absolute temperature scale. The equation of state of perfect gases.

**Heat and internal energy:** The concept of quantity of heat. Unit of measurement of heat. Heat capacity and specific heat of a substance. Fundamental equations of calorimetry. The internal energy of a system. The principle of thermodynamics. Thermodynamic transformations. Status changes. Metabolic power. Energy value of food. Thermoregulation

**Sound:** wave phenomena. Elastic and electromagnetic waves. Nature of sound. Wavelength. Sound intensity. Technical applications and biological effects of ultrasound. Ultrasound in medical diagnostics.

**Electrical phenomena:** Electric charge. Conductors and insulators. Electric field and electric field strength. Coulomb's law. Unit of measurement of electric charges. Dielectric constant. Electric potential and potential difference. Electric capacitors. Electric current and current intensity. Direct current. Energy considerations on electrical circuits. Ohm's laws. Electrical resistance and resistivity. Resistors in series and in parallel. Joule effect. Power absorbed by a device. Electrical safety.

**Radiation:** Introduction to radiation. Radiation. Radioactivity. Radioactive decays. Law of radioactive decay. Interaction of radiation with matter and dosimetry. Radiation protection.

### **Computer Science**

Introduction to the world of computers.

The hardware of IT systems (CPUs, memories, Input/Output devices);

Computer language: coding systems;

System software: operating system and utilities.

Main application software: word processing programs, electronic spreadsheets, databases;

Upcoming developments in IT systems.

Social impact of IT technologies.

### **TEACHING METHODS**

The integrated course is divided into lectures, 30 hours of Statistics, 30 hours of Physics and 20 hours of Computer Science. The frontal teaching includes lectures, exercises and integrative seminars on both theoretical and applicative topics, with reference to real case studies. Teachers also make use of teaching tools such as presentations organized in powerpoint files with explanatory diagrams, illustrations and images. The initial lessons of Physics are aimed at recovering the concepts and mathematical skills that are indispensable prerequisites for a successful development of integrated teaching. The teaching methodology tends to stimulate the active participation of students and makes them protagonists of the lesson through "inverted teaching" activities.

### **HOW TO TEST LEARNING**

In line with the objectives of the course, the assessment of learning will evaluate the student's ability to apply the knowledge learned and will ensure that the skills are adequate to solve the problems that arise in the specific disciplinary field.

The evaluation of the course of Mathematical, Physical and Computer Sciences, consists of a written test and an oral test to be taken in the same appeal. Only students who have obtained a score  $\geq 18/30$  in the written test are admitted taking the oral exam.

- The written test consists of multiple choice questions on the topics of the courses that make up the integrated course and is aimed at assessing the knowledge and understanding of the program carried out and the ability to apply the skills gained.
- The oral exam consists of the discussion of the written test and questions concerning the programs of the disciplines and aims to evaluate the ability to synthesize, the clarity of the exposition, the rigor of the terminology used and the autonomy of judgment.

The exam will be evaluated according to the following criteria:

**Unsuitable:** important deficiencies and/or inaccuracies in the knowledge and understanding of the topics; limited analytical and synthesis skills, frequent generalizations.

**18-20:** knowledge and understanding of the topics just enough with possible imperfections; sufficient synthetic analysis skills and autonomy of judgment.

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

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

**27-29:** complete knowledge and understanding of the topics; remarkable analytical skills, synthesis. Good autonomy of judgment.

**30-30L:** excellent level of knowledge and understanding of the topics. Remarkable skills of analysis and synthesis and autonomy of judgment. Arguments expressed in an original way

### **SUPPORT ACTIVITIES**

There are no optional or external activities beyond the number of hours required by the integrated course.

### **RECOMMENDED TEXTS AND BIBLIOGRAPHY**

#### **Medical Statistics**

- Martin Bland, *Statistica medica*, Seconda Edizione, Maggioli Editore
- Teacher notes

#### **Medical Physics**

- Teacher notes
- Gian Marco Contessa- Giuseppe Augusto Marzo ; *Fisica applicata alle scienze mediche*- Casa Editrice Ambrosian
- Ezio Ragozzino, *Elementi di Fisica per studenti di Scienze Biomediche* –EdiSES - 2 ediz.
- Paul Davidovits: *Fisica per le professioni sanitarie*- UTET.

#### **Computer Science**

- Deborah Morley and Charles S. Parker, *Understanding Computers: Today and Tomorrow (16th.edition)* - Cengage Learning
- Teacher notes

### **COORDINATOR AVAILABILITY**

Students can be received by appointment by writing or at the following address:

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