Degree Course in Physioterapy

Integrated Teaching: PHYSICS, STATISTICS AND INFORMATION TECHNOLOGY
CFU: 8
SSD: FIS/07- INF/01- MED/01- ING-INF/05
Coordinator: Indovina Iole **e-mail: iole.indovina@unicamillus.org**

MODULE: Applied Physics
CFU: 2
SSD: FIS/07
Professor: INDOVINA IOLE e-mail: iole.indovina@unicamillus.org

MODULE: Information Technology
CFU: 2
SSD: INF/01
Professor: ANDREA D'AMBROGIO e-mail: andrea.dambrogio@unicamillus.org

MODULE: Medical Statistics
CFU: 2
SSD: MED/01
Professor: LUCA WELTERT e-mail: luca.weltert@unicamillus.org

MODULE: Data Processing Systems
CFU: 2
SSD: ING-INF/05
Professor: ANDREA D'AMBROGIO e-mail: andrea.dambrogio@unicamillus.org

PREREQUISITES

INFORMATION TECHNOLOGY
No prerequisite.

DATA PROCESSING SYSTEMS
In order to get a full comprehension of the covered topics it is essential to have the knowledge obtained in the Information Technology module.

APPLIED PHYSICS
Knowledge and competence in Basic Mathematichs, Physics and Statistics at High School level.

MEDICAL STATISTICS
A prior knowledge of basic mathematics and a confidence in basic IT tools is required.

LEARNING OBJECTIVES

INFORMATION TECHNOLOGY

The course intends to provide students with the basic knowledge to understand the essential role of Information Technology (IT) in our society, and specifically in the context of health-related technical professions.

DATA PROCESSING SYSTEMS

The course intends to provide students with the basic knowledge to understand the role of Information Systems and their lifecycle, specifically focusing on database management systems.

APPLIED PHYSICS

Aim of the course of Medical Physics within the integrated course of Physics, statistics and information technology is to provide students with knowledge on the fundamentals of applied physics necessary to the performance of their future activity. In particular, the comprehension of physical principles at the base of medical physics and of functioning of medical instrumentation will be addressed.At the end of the course, the students will know the fundamental concepts of application of the Scientific Method to the study of biomedical phenomena (choice and measure of parameters, evaluation of errors), they will be able to describe physical phenomena of complex systems using suitable mathematical tools, they will know the scientific basis of medical procedures and principles of functioning of the equipment commonly used for diagnostics and therapeutics.

MEDICAL STATISTICS

The Medical Statistics course aims to introduce students to the logic of statistical thinking and its application in everyday life. The exposition of the topics will be oriented towards concrete problems of analysis and research, starting from schematic examples and then confronting real situations taken from the medical literature.

LEARNING OUTCOMES

INFORMATION TECHNOLOGY

At the end of the course the student will master the IT terminology and will get a basic knowledge of the characteristics of both modern IT systems and their main applications. Specifically, students get the elements that contribute to define the architecture of an IT system in terms of the relevant hardware and software components (applying knowledge and understanding). The topics covered in the course are applied to different case studies, so to stimulate the student decision making abilities (making judgements), as well as the communication skills and learning skills.

DATA PROCESSING SYSTEMS

At the end of the course the student will master the Information Systems terminology and will get a basic knowledge of the characteristics of modern Information Systems and Database Management Systems. Specifically, students get the elements that contribute to define the architecture of an Information System in terms of the relevant components (applying knowledge and understanding), with specific application to Database Management Systems. The topics covered in the course are applied to different case studies, so to stimulate the student decision making abilities (making judgements), as well as the communication skills and learning skills.

APPLIED PHYSICS

The specific learning outcomes of the program are coherent with the general provisions of the Bologna Process and the specific provisions of EC Directive 2005/36/EC. They lie within the European Qualifications Framework (Dublin Descriptors) as follows:

1. Knowledge and Understanding :

- *Understand the experimental method and learn the use and transformation of measure units.*
- *Know and understand the proper terminology of physics.*
- *Know and understand the main physical principles and laws concerning kinetics, dynamics, electricity and magnetism, vibration and waves, radiation, balance regulating principles and fluids.*
- *Apply these concepts to biological and physiological phenomena in living organisms.*
- *Identify and recognize the physical principles which govern the function of the specific human organs.*

2. Applying Knowledge and Understanding

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

3. Communication Skills

- *Present the topics orally in an organized and consistent manner.*
- *Utilize a proper scientific language coherent with the topic of discussion.*

4. Making Judgements

- *Recognize the importance of an in-depth knowledge of the topics consistent with a proper medical education.*
- *Identify the fundamental role of a proper theoretical knowledge of the topic in the clinical practice.*

MEDICAL STATISTICS

Knowledge and understanding

At the end of this teaching the student will need to know:

- *Understand and manage the statistical tools needed to describe and analyze a data table*
- *Describe the theoretical basis for extracting useful information from data and making informed decisions*
- *Know the most common contemporary software suites*
- *Perform differential descriptive statistics in person*
- *Perform low grade inferential statistics in person*
- *Distinguish the regression methods*
- *Distinguish the control methods of confounding a posteriori*
- *Know and describe the types of longitudinal statistical study and their implementation*

Applying knowledge and understanding

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

• *Use the knowledge acquired for an in-depth study of aspects relating to the specific field to which the student will dedicate himself in the context of his professional activity;*
• *Particular emphasis will be given to statistical reasoning, interpretation and decision-making, to this end we will insist more on conceptual understanding than on mechanical calculation, also in light of the wide choice of software available for analysis*

Communication skills
At the end of the course the student must know:
• *Use specific scientific terminology appropriately.*
• *Understand the methodological statements relating to the calculation paragraphs in scientific publications*

Making judgements
At the end of the course the student must know:
•.*how to make general assessments of the topics covered.*
• *distinguish in scientific literature articles the application of statistical appropriateness described in support of the same*

COURSE SYLLABUS

INFORMATION TECHNOLOGY

Introduction to IT systems
The hardware part of IT systems
- *CPU*
- *Memory*
- *Input/Output)*

The software part of IT systems
- *system software (operating systems and utility programs)*
- *application software (word processing, spreadsheet, database, etc.)*

DATA PROCESSING SYSTEMS

Introduction to Information Systems
Information System types
The lifecycle of Information Systems
Database and Database Management System (DBMS)

APPLIED PHYSICS

*Chapter **1:** Introduction, Measurement, Estimating*

1.4: Measurement and Uncertainty; Significant Figures
1.5: Units, Standards, and SI Units
1.6: Converting Units
1.8: Dimensions and Dimensional Analysis

*Chapter **2:** Describing Motion: Kinematics in One Dimension*

2.1: References Frames and Displacement

2.2: Average Velocity
2.3: Instantaneous Velocity
2.4: Acceleration
2.5: Motion at Constant Acceleration

*Chapter **3:** Kinematics in Two Dimensions; Vectors*

3.1: Vectors and Scalars
3.2: Addition of Vectors-Graphical Methods
3.3: Subtraction of Vectors and Multiplication of a Vector by a Scalar
3.4: Adding Vectors by Components

*Chapter **4:** Dynamics: Newton's Laws of Motion*

4.1: Force
4.2: Newton's First Law of Motion
4.3: Mass
4.4: Newton's Second Law of Motion
4.5: Newton's Third Law of Motion
4.6: Weight-The Force of Gravity; and the Normal Force
4.7: Solving Problems with Newton's Laws: Free-Body Diagrams
4.8: Problems Involving Friction, Inclines
4.9: Problem Solving-A General Approach

*Chapter **5:** Circular Motion; Gravitation*

5.1: Kinematics of Uniform Circular Motion
5.2: Dynamics of Uniform Circular Motion
5.6: Newton's Law of Universal Gravitation

*Chapter **6:** Work and Energy*

6.1: Work Done by a Constant Force
6.3: Kinetic Energy and the Work-Energy Principle
6.4: Potential Energy
6.5: Conservative and Nonconservative Forces
6.6: Mechanical Energy and its Conservation
6.7: Problem Solving Using Conservation of Mechanical Energy
6.8: Other Forms of Energy: Energy Transformations and the Law of Conservation of Energy
6.10: Power

*Chapter **7:** Linear Momentum*

7.1: Momentum and Its Relation to Force
7.2: Conservation of Momentum
7.8: Center of Mass (CM)
7.10: Center of Mass and Translational Motion

*Chapter **9:** Static Equilibrium; Elasticity and Fracture*

9.1: The Conditions for Equilibrium
9.2: Solving Statics Problems
9.3: Applications to Muscles and Joints
9.4: Stability and Balance
9.5: Elasticity; Stress and Strain
9.6: Fracture

*Chapter **14:** Heat*

14.1 Heat as Energy Transfer
14.2 Internal Energy
14.3: Specific Heat
14.4: Calorimetry
14.5: Latent Heat
14.6: Heat Transfer: Conduction

Fluids

*Chapter **10:** Fluids*

10.1: Phases of Matter
10.2: Density and Specific Gravity
10.3: Pressure in Fluids
10.4: Atmospheric Pressure Gauge Pressure
10.5: Pascal's Principle
10.6: Measurement of Pressure; Gauges and the Barometer
10.7: Buoyancy and Archimedes' Principle

Vibrations and Waves

*Chapter **11:** Vibrations and Waves*

11.7: Wave Motion
11.8: Types of Waves: Transverse and Longitudinal
11.9: Energy Transported by Waves
11.10: Intensity Related to Amplitude and Frequency

*Chapter **12:** Sound*

12-1 Characteristics of Sound
12-2 Intensity of Sound: Decibels
12-7 Doppler Effect

Electricity and Magnetism

*Chapter **16:** Electric Charge and Electric Field*

16.1: Static Electricity; Electric Charge and its Conservation
16.2: Electric Charge in the Atom
16.3: Insulators and Conductors
16.4: Induced Charge; the Electroscope
16.5: Coulomb's Law
16.6: Solving Problems Involving Coulomb's Law and Vectors
16.7: The Electric Field
16.8: Field Lines
16.9: Electric Fields and Conductors

*Chapter **17:** Electric Potential*

17.1: Electric Potential Energy and Potential Differences
17.2: Relation between Electric Potential and Electric Field
17.3: Equipotential Lines
17.4: The Electron Volt, a Unit of Energy
17.5: Electric Potential Due to Point Charges
17.7: Capacitance
17.8: Dielectrics
17.9: Storage of Electric Energy

*Chapter **18:** Electric Currents*

18.1: The Electric Battery
18.2: The Electric Current
18.3: Ohm's Law: Resistance and Resistors
18.4: Resistivity
18.5: Electric Power

*Chapter **19:** DC Circuits*

19.1: EMF and Terminal Voltage
19.2: Resistors in Series and in Parallel
19.3: Kirchhoff's Rules
19.4: EMFs in Series and in Parallel; Charging a Battery
19.5: Circuits Containing Capacitors in Series and in Parallel
19.6: RC Circuits-Resistor and Capacitor in Series

*Chapter **22:** Electromagnetic Waves*

22.1: Changing Electric Fields Produce Magnetic Fields; Maxwell's Equations
22.2: Production of Electromagnetic Waves
22.3: Light as an Electromagnetic Wave and the Electromagnetic Spectrum

22.5: Energy in EM Waves

*Chapter **24:** The Wave Nature of Light*

24.4: The Visible Spectrum and Dispersion

*Chapter **25:** Optical Instruments*

25-11: X-Rays and X-Ray Diffraction
25-12: X-Ray Imaging and Computed Tomography (CT Scan)

MEDICAL STATISTICS

*The first part of the course will introduce the logic of statistics and experimental design.The concepts of probability calculation and combinatorial calculation will be introduced or recalled; although theoretically already in possession of the student, these steps are fundamental and will be used in the continuation of the course. In this phase the main probability distributions will be treated, including the binomial distribution, the Poisson distribution and the standard Normal and Normal distributions, but more than the single mathematical process,we will try making the student aware of the deep motivation of the medical statistics, as a science, and its application in practice, as well as the risks of its incorrect understanding.In the second part of the course the descriptive statistics and its methodology will be addressed. It will be shown how to recognize the type of data and how to summarize them in appropriate indexes.The student will learn how to calculate position measurements (mean, median, fashion), variability (variance, standard deviation), coefficient of variation (CV), percentiles and their use. It will also make extensive use of practical examples to define a good descriptive statistic and a defective or deceptive descriptive statistic.*In the final part of the course the general principles of statistical inference will be treated. Cases of sample distribution, type I and II errors, power of a test and operating curve will be introduced. We will then move on to parametric tests - Student's t-test, ANOVA with 1 and 2 classification criteria, non-parametric tests: - Wilcoxon test, Mann-Whitney test, Kruskal-Wallis test, Friedman test, median test, chi-square test, Fisher exact test. We will also provide the basic concepts of regression and analysis of time dependent variability with mention of Kaplann Meyer functions, log rank and Cox regression.

COURSE STRUCTURE

All teaching modules are structured in 20 hours of frontal teaching, divided into 2, 3 or 4 hours lessons according to the academic calendar. Attendance is compulsory for at least 75% of the hours, added up on all the lessons of the integrated course. Preliminary to the course, a recovery of the concepts and mathematical skills that are essential prerequisites for a successful course of the Integrated Course is carried out.

COURSE GRADE DETERMINATION

APPLIED PHYSICS

The Physics test consists of a compulsory written test and an optional oral test. The written and oral tests are aimed at assessing both the theoretical knowledge and the student's ability to solve problems. The written test consists of 15 multiple choice questions. Each correct answer gets a

score of 2/30, while there is no penalty for the wrong answers. Only students who have obtained a written test of at least 12/30 are admitted to the oral exam.
Mark less than 12 in the written test: the writing must be repeated in a subsequent appeal.
Mark from 12 to 16 in the written test: the student must necessarily take the oral test.
Mark from 18 to 30L in the written test: the student can optionally take the oral test.
The exam mark, expressed in thirtieths, is established according to the following criteria:
Not suitable: important shortcomings and / or inaccuracy in the knowledge and understanding of the topics; limited analysis and synthesis skills, frequent generalizations.
18-20: Knowledge and understanding of the subjects just enough.
21-23: Knowledge and understanding of discreet topics.
24-26: Good knowledge and understanding of the topics.
27-29: Full knowledge and understanding of the topics.
30-30L: Excellent level of knowledge and understanding of the topics.

INFORMATION TECHNOLOGY
The exam is carried out in written form, in a traditional or computerized classroom, by administering a test with multiple choice questions.

MEDICAL STATISTICS
The assessment of the achievement of the objectives set out in the module provides a written test, consisting mainly of open-ended questions on topics covered in the course. In this way, it will be ascertained the student's knowledge and understanding of both the theoretical principles and their consequences in the medical and biological fields.
The written test will also include the resolution of one or more problems, to verify the achievement of the objective of the ability to apply the acquired knowledge to a simulated situation of biological or medical interest..
The evaluation of the works will attribute the same weight to the answers to the open questions and to the proposed problems. In the process of delivering the papers and transcribing the vote, the student will be given the opportunity to further externalize his / her knowledge and supplement the written test.

DATA PROCESSING SYSTEMS
The exam is carried out in written form, in a traditional or computerized classroom, by administering a test with multiple choice questions.

OPTIONAL ACTIVITIES
MEDICAL STATISTICS
Practical complementary teaching activities, with seminars and working exercises on statistical software will be communicated and planned during the course.

APPLIED PHYSICS
In addition to the teaching activity, the student will be given the opportunity to participate in seminars, research internships, department internships and monographic courses. The topics of the activities are not subject to examination. Acquisition of the hours allocated occurs only with a mandatory frequency of 100%.

READING MATERIALS

APPLIED 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.

MEDICAL STATISTICS

1) Notes of the lessons
2) Stanton A. Glantz: Statistics for Bio-medical disciplines - ed. McGraw-Hill
3) Sidney Siegel, N. John Castellan Jr.: - Non parametric statistics - ed. McGraw-Hill
4) Resources and links from the Internet with particular reference to the use of the PubMEd portal

DATA PROCESSING SYSTEMS

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

INFORMATION TECHNOLOGY

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