Degree Course in Biomedical Laboratory Techniques

MODULE: Medical Statistics
SSD: MED / 01
Number of ECTS: 3
Teacher name: Michel Petschette EMAIL: michel.pletschette@unicamillus.org, michel.pletschette@lrz.uni-muenchen.de

MODULE: Medical Physics
SSD: FIS / 07
Number of ECTS: 3
Teacher name: Maria Giovanna Guerrisi, EMAIL mariagiovanna.guerrisi@unicamillus.org

Module: Information Technology
SSD: INF / 01
Number of ECTS: 2
Teacher name: Prof. Paolo Montanari EMAIL paolo.montanari@unicamillus.org

METHOD OF ATTENDANCE: MANDATORY WITH AT LEAST 75% OF INTEGRATED TEACHING ATTENDANCE

PREREQUISITES

Although there is no prerequisite, a previous knowledge of basic mathematics and a familiarity with basic computer tools as well as basic physics and statistics are required at secondary school level.

EDUCATIONAL OBJECTIVES

The Medical Statistics course aims to provide students with the basic notions of physics, statistics and computer science, the purpose of which is the logic of statistical thinking and its application in real practice. The exposition of the topics will be oriented to concrete problems of analysis and research, starting from schematic examples and then confronting with real situations taken from the medical literature.

The purpose of the integrated teaching of Mathematical, Physical and Computer Sciences (Medical Physics, Medical Statistics and Computer Science) is to provide students with the knowledge on the foundations of applied physics necessary for the performance of their future activity, the principles of information technology and the principles of physics, applied to their professional profile. In particular, the understanding of the physical principles underlying medical physics and the functioning of medical instrumentation will be addressed.

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 be able to describe the physical phenomena of complex systems using suitable mathematical tools, they will know the scientific basis of medical procedures and the operating principles of the equipment commonly used for

diagnostics and therapy, as well as providing the student with the skills necessary to understand the key role that Information Technology (IT) plays for today's society and, in particular, in the field of technical and health professions

EXPECTED LEARNING RESULTS

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:

Knowledge and understanding
At the end of this course the student will have to know:

o Understand the statistical tools needed to describe and analyze a data table
o Understand the theoretical basis for extracting useful information from data and making informed decisions

o Know and memorize the most popular contemporary Software Suites
o Know and understand firsthand the differential descriptive statistics

o Know and understand low-grade inferential statistics firsthand
o Comprehend and apply regression methods

o Knowing the methods of controlling confounding a posteriori
o Know and describe the typologies of longitudinal statistical study and their implementation

o Having understood the experimental method and having acquired the rigor in the use and transformations of units of measurement.
o Know and understand correctly the terminology of physics.

o Know the fundamental principles and laws of physics regarding kinematics, dynamics, electricity and magnetism, vibrations and waves, radiation, nuclear physics and fluids.

o Know and understand the concepts of biological and physiological phenomena in living organisms.

o Know and understand the physical principles that regulate the function of specific human organs.
o Basic knowledge of the characteristics of modern IT systems

o Knowledge of the main applications of IT systems
o Knowledge of the elements that contribute to defining the architecture of an IT system in terms of the relative hardware and software components that compose them

o Know the difference between basic software and application software
o Know and know how to apply the use of software to specify the actions that a computer must perform

o Knowing the social impact of computers and IT technologies.

Ability to apply knowledge and understanding

At the end of the course, the student will be able to:
o Apply the acquired knowledge for the autonomous deepening of aspects related to the specific field to which the student will dedicate himself in the context of the professional activity;
o Particular emphasis will be given to statistical reasoning, interpretation and decision-making, to this end emphasis will be placed more on conceptual understanding than on mechanical calculation, also in light of the wide choice of software available for analysis

o Apply the principles of physics to selected problems and a varying range of situations.

o Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.
o how to apply the knowledge and technologies learned in the course to real application contexts

Communication skills

At the end of the course, the student must know:
o Use specific scientific terminology appropriately.
o Understand the methodological statements relating to the calculation paragraphs found in scientific publications

o Orally present the arguments in an organized and coherent way.
o Use of a scientific language that is adequate and consistent with the topic of the discussion.

or how to properly use the terminology commonly adopted around the world
IT

Autonomy of judgment

At the end of the course, the student must know:
o carry out general assessments relating to the topics covered.
o distinguish the application of statistical appropriateness described in support of the same in articles of scientific literature
o Recognize the importance of a thorough knowledge of the topics consistent with adequate medical education.

o Identify the fundamental role of correct theoretical knowledge of the subject in clinical practice
o knowledge and competence adequate to be familiar with IT systems and their components

These expected learning outcomes are measurable with the final assessment

SYLLABUS

Medical statistics
The first part of the medical statistics module will introduce the logic of statistics and experimental design.

The concepts of probability calculus and combinatorics will be introduced or recalled which, although in theory already in the possession of the student, are fundamental and will be used later in the course. In this phase we will deal with the main probability distributions including the binomial distribution, the Poisson distribution and the standard Normal and Normal distributions, but even more than the single mathematical process we will want to transfer to the student the

profound motivation for the existence of medical statistics as a science and its application, as well as the risks of its incorrect understanding.

In the second part of the module, 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 the measures of position (mean, median, mode), variability (variance, standard deviation), the coefficient of variation (CV), percentiles and their use. Extensive use will also be made of practical examples to define good descriptive statistics and poor or misleading statistics.

In the third part of the course, the general principles of statistical inference will be treated.
The concepts of sampling distribution, type I and II error, power of a test will be introduced
and operating curve.
The following will therefore be treated:
parametric tests - Student's t test, ANOVA at 1 and 2 classification criteria. non-parametric tests: - Wilcoxon test, Mann-Whitney test, Kruskal-Wallis test, Friedman test, median test, chi-square test, Fisher's exact test. The basic concepts of regression and analysis of time dependent variables will also be provided with a mention of Kaplann Meyer functions, log rank and Cox regression.

In the final part, the various topics of diagnostic correctness of laboratory tests will be treated such as specificity, sensitivity, predictive value etc. In addition, the meaning of the ROC curve and the methods of verifying the reliability of a test will be discussed (figure by Bland-ALtmann)

Medical physics
Mechanics
Chapter 1: Introduction, measurement, estimation
1.4: measurement and uncertainty; Significant figures
1.5: units, standards and SI units
1.6: Conversion of units

1.8: Dimensions and dimensional analysis
Chapter 2: Description of motion: kinematics in one dimension

2.1: Reference and displacement systems

2.2: average speed

2.3: instant speed

2.4: acceleration

2.5: constant speed movement

Chapter 3: kinematics in two dimensions; Vectors

3.1: Vectors and scalars

3.2: Sum of vectors - Graphical methods

3.3: Subtracting vectors and multiplying a vector with a scalar

3.4: Sum of 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 normal Force

4.7: Problem solving with Newton's laws: free body diagrams

4.8: Problems involving friction, inclinations

4.9: Troubleshooting: 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 principle of the energy of work

6.4: Potential energy

6.5: Conservative and Non-Conservative Forces

6.6: Mechanical energy and its conservation

6.7: Troubleshooting using mechanical energy conservation

6.8: Other forms of energy: energy transformations and the law of conservation of energy

6.10: Power

Chapter 7: Linear moment

7.1: Moment and its relation to force

7.2: Preservation of the moment

7.8: Center of mass (CM)

7.10: Center of mass and translational movement

Chapter 9: Static Equilibrium; Elasticity and fracture

9.1: The conditions for equilibrium

9.2: Solving Statics Problems

9.3: Applications on muscles and joints

9.4: stability and balance

9.5: Elasticity; Stress and tension

9.6: Fracture

Thermodynamics

Chapter 13: Theory of temperature and kinetics

13.1: Atomic theory of matter

13.2: temperature and thermometers

13.3: Thermal equilibrium and Zeroth's law of thermodynamics

13.4: Thermal expansion

13.6: The laws of gas and absolute temperature

13.7: The ideal gas law

13.8: Solving problems with the ideal gas law

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

14.7: Heat transfer: convection

14.8: Heat transfer: radiation

Chapter 15: The laws of thermodynamics

15.1: The first law of thermodynamics

15.2: thermodynamic processes and the first law

Fluids

Chapter 10: Fluids

10.1: Phases of Matter

10.2: Density and specific gravity

10.3: Pressure in fluids

10.4: Pressure relative to atmospheric pressure

10.5: Pascal's principle

10.6: Pressure measurement; Calipers and 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 carried by waves

11.10: Intensity relative to amplitude and frequency

Chapter 12: Sound

12-1 Sound characteristics

12-2 Sound intensity: 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 concerning 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: Relationship between electric potential and electric field

17.3: Equipotential lines

17.4: The Electronvolt, a unit of energy

17.5: Electric potential due to point charges

17.7: Capacity

17.8: Dielectrics

17.9: electrical energy storage

Chapter 18: Electric currents

18.1: The electric battery

18.2: Electric current
18.3: Ohm's law: resistance and resistors

18.4: resistivity

18.5: electricity

Chapter 19: DC circuits

19.1: EMF and terminal voltage

19.2: Resistors in series and in parallel

19.3: Kirchhoff rules

19.4: EMF in series and in parallel; Charging a battery

19.5: Circuits containing capacitors in series and in parallel

19.6: RC-Resistor and capacitor in series circuits

Chapter 20: Magnetism

20.1: Magnets and magnetic fields

20.2: Electric current produces magnetic fields

20.3: Force on an electric current in a magnetic field: definition of B.

20.4: Force on an electric charge moving in a magnetic field

20.5: magnetic field due to a long and straight cable

20.8: Ampere's Law

Chapter 21: Electromagnetic induction and Faraday's law

21.1: EMF induced

21.2: Faraday's law of induction; Lenz's law

21.3: EMF induced in a moving conductor

21.4: The change in magnetic flux produces an electric field

Chapter 22: Electromagnetic Waves

22.1: the change in electric fields produces 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: Visible spectrum and dispersion

Chapter 25: Optical instruments

25-11: X-rays and X-ray diffraction

25-12: X-ray imaging and tomography.

Informatic tecnology
Introduction to IT systems
The hardware of IT systems (CPU, memory, Input / Output)
IT systems software: system software (operating system and utility programs), application software (word processing, spreadsheets, databases, etc.)

TEACHING METHOD

The Medical Statistics module is structured in 30 hours of frontal teaching, divided into lessons of 2 or 4 hours according to the academic calendar. The lectures include lectures, exercises and supplementary seminars on the topics covered.

During the lectures, the topics contained in the module program will be illustrated and commented on. Exercises will follow at the end of the theory relating to each topic
which will illustrate its application in practice. The procedure and the step-by-step execution of the necessary calculations will be described. It will also show both the manual execution and, in the more advanced phase of the course, the solution obtained through the use of special software, with particular reference to the MedCalc suite and SPSS v22.0 (IBM Corp). In order to place what was learned in each lesson in the scientific context and verify its practical usefulness, each lesson will be concluded by reading scientific articles with particular attention to the statistical part and its relative importance in the design of the study.

Medical Physics the module is structured in 30 hours of frontal teaching with practical exercises, divided into 2-hour lessons based on the academic calendar. Preliminarily to the course, a recovery of mathematical concepts and skills is carried out, which are indispensable prerequisites for a successful completion of the Integrated Course.

Information technology: the module is structured in 20 hours of frontal teaching and involves lectures on both theoretical and applicative topics, with reference to real case studies

LEARNING VERIFICATION METHOD

The integrated teaching exam consists of an oral exam, during which the commission will assess 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 and taking I also take into account the objectives of the teaching. The exam can be passed with a grade of 18/30. The student's learning ability, judgment ability and communication skills will be assessed. In the evaluation, knowledge and understanding have a weight of 50%, knowledge and understanding of 20% and autonomy of judgment of 30%

The student can take the exam in a single session in the recovery session (September / January), while the exam can be taken in two separate sessions in the ordinary sessions (February / July)

The assessments can be carried out both in progress and at the end of the integrated course. The methodology will be communicated at the beginning of the lessons together with the bibliography and / or teaching materials necessary for the preparation for the final evaluation.

• Oral exam: It will focus on questions concerning the study programs. It will evaluate the student's ability to have acquired the knowledge related to the contents of the courses and their integrations, and will ascertain the appropriate use of terminology.
• Written test: It will focus on the programmed topics of the courses that make up the integrated course.
The exam will be assessed according to the following criteria:

Not suitable: Poor or lacking knowledge and understanding of the topics; limited capacity for analysis and synthesis, frequent generalizations of the requested contents; inability to use technical language.
18-20: Just enough knowledge and understanding of the topics, with obvious imperfections; just sufficient capacity for analysis, synthesis and autonomy of judgment; poor ability to use technical language.
21-23: Sufficient knowledge and understanding of the topics; sufficient ability to analyze and synthesize with the ability to reason with logic and coherence the required contents; sufficient ability to use technical language.
24-26: Fair knowledge and understanding of the topics; discrete ability to analyze and synthesize with the ability to rigorously argue the required contents; good ability to use technical language.
27-29: Good knowledge and understanding of the required contents; good ability to analyze and synthesize with the ability to rigorously argue the required contents; good ability to use technical language.
30-30L: Excellent level of knowledge and understanding of the required content with an excellent ability to analyze and synthesize with the ability to argue the required content in a rigorous, innovative and original way; excellent ability to use technical language.

SUPPORT ACTIVITIES

MEDICAL STATISTICS: Practical supplementary didactic activity, with seminars and work exercises on statistical software, will be communicated and planned during the course.

MEDICAL PHYSICS: The elective didactic activities chosen by the student are offered by the Integrated Course and include Seminars, Research Internships, Departmental Internships and Monographic Courses. The arguments of the A.D.E. they are not subject to examination. The acquisition of the hours attributed to the A.D.E. takes place only with a mandatory 100% attendance.
INFORMATION TECHNOLOGY: No support activities are foreseen

SUGGESTED TEXTS AND BIBLIOGRAPHY

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.

MEDICAL PHYSICS
Douglas C. Giancoli "PHYSICS: Principles with applications" Third edition or later, Ambrosiana Publishing House.

The textbooks shown are for reference only. Students are allowed to adopt the book (s) of their choice. Additional material will be provided by the teacher.

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

RESPONSIBLE AVAILABILITY

Students are received by appointment by writing or using the following address:
Prof.ssa Maria Giovanna Guerrrisi
email: mariagiovanna.guerrisi@unicamillus.org