Degree in Radiology, Diagnostic imaging, and radiotherapy techniques

INTEGRATED COURSE: INFORMATION TECHNOLOGY, STATISTICS, AND PHYSICS APPLIED TO RADIOLOGICAL SCIENCE

SSD: : MEDS-24/A (ex MED/01), IINF-01/A(ex INF/01), IINF-05/A (ex Ing-Inf/05), PHYS-06/A (ex FIS/07)
CFU: 8
Docente: Alessio Lachi
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TEACHING: Medical Statistics Applied to Radiological Sciences
SSD: MEDS-24/A (ex MED/01)
Number of CFU: 1
PROFESSOR:: Alessio Lachi
e-mail: alessio.lachi@unicamillus.org

TEACHING: Information Technology applied to Radiological Sciences
SSD: IINF-01/A(ex INF/01),
Number of CFU: 2
PROFESSOR: Luca Del Greco
e-mail: luca.delgreco@unicamillus.org

TEACHING: Data Processing and Storage
SSD: IINF-05/A (ex Ing-Inf/05)
Number of CFU: 2
PROFESSOR: : Alessandro Leonelli
e-mail: alessandro.leonelli@unicamillus.org

TEACHING: Basics of Physics and Physics of Radiation
SSD: PHYS-06/A (ex FIS/07)
Number of CFU:1
PROFESSOR: Luca Burratti
e-mail: luca.burratti@unicamillus.org

TEACHING: Basics of Physics and Physics of Radiation
SSD: PHYS-06/A (ex FIS/07)
Number of CFU 2
PROFESSOR: Sara Spadone
e-mail: sara.spadone@unicamillus.org

PREREQUISITES

Although there are no prerequisites, a minimum basic knowledge of mathematics, physics, and basic statistics is required.

LEARNING OBJECTIVES

It is an essential objective of the Medical Statistics Applied to Radiological Sciences module to learn the knowledge of essential elements of medical statistics, which include: parameters for descriptive analysis (average, median, mode, and frequency measurement of the distribution of categorical variables), parameters for the analysis of variability (variance and standard deviation,) and introductory elements to probability calculation.

The module of Information Technology applied to Radiological Sciences aims to provide the student with the skills necessary to understand the key role that Information Technology (IT) plays in today's society and, in particular, in the technical-health professions.

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

The aim of the module on Basic Physics and Radiation Physics is to provide students with basic knowledge of applied physics and appropriate mathematical tools essential for their future professional activities. Students will learn the scientific bases and operating principles of commonly used diagnostic and therapeutic equipment, as well as the physical principles governing medical physics, including the phenomena of ionization and the interaction of radiation with matter. These concepts are essential for understanding the operation of medical equipment and diagnostic and therapeutic techniques. The course will include an in-depth study of the scientific foundations of medical procedures and the operating principles of equipment commonly used for diagnosis and therapy as well as aspects of radiation protection.

LEARNING OUTCOMES

Knowledge and understanding

At the end of the module, the student will learn:

- Classify the variables according to their form; understand and calculate the extent of the distribution of different variables; understand and calculate the measure of sample variability; manage the key concepts of probability..
- Know databases and database management systems.
- Know the basic characteristics of modern IT systems, an understanding of the main applications of IT systems, the elements that contribute to defining the architecture of an IT system in terms of the relative hardware and software components that compose them, the difference between base and application software, the use of software to specify the actions that a computer must perform, the social impact of computers and IT technologies. What computer systems are and why they are needed. The different types of IT systems commonly adopted in companies and their purposes, the development cycle (life cycle) of an IT system, a basic knowledge of programming languages and coding, the different approaches to software development (object-oriented, structured, etc.), and what databases are and what database management systems are.
- Understand the basic principles and fundamental laws of physics concerning kinematics, dynamics, electricity and magnetism, waves, radiation, and atomic physics. Understand, based on these principles, the operation of radiological equipment for diagnosis and therapy, as well as the modes of interaction of radiation with biological matter. Acquire skills in the use of appropriate mathematics, including the transformation of units of measurement and orders of magnitude. Know and correctly understand the specific terminology of physics.

Applying knowledge and understanding

At the end of the module, the student will be able to:

- Use the knowledge acquired for the deepening of elementary aspects relating to the use of statistics in the radiological field and to relate knowledge of causes with other professionals in the health sector.
- Apply the IT knowledge explained in the module and the tools used to real cases of application in the health sector;
- Apply knowledge of database structures and data management to real-world healthcare application cases;
- Knowing the principles of physics in diagnostic and therapeutic contexts, the physical quantities involved, and how they influence clinical practice.

Communication skills
At the end of the module, the student must know how to: express themselves using specific scientific terminology. Use the appropriate scientific and technical terminology also in relation to the different radiological techniques. How to properly use the terminology commonly adopted in the IT world.

Making judgements
At the end of the module, the student will have to:
- know how to carry out general assessments of the potential of medical statistics in both care and clinical research.
- Have adequate knowledge and skills to be familiar with IT systems and their components;
- Have adequate knowledge and skills to be familiar with IT systems, database management systems, and their life cycles.
- Be able to make assessments on the parameters and physical quantities involved in diagnostic, therapeutic, and radiation protection contexts.

Learning skills
The student will have acquired learning skills and methods suitable for deepening and improving his or her skills in the fields of statistics, computer science, and physics, also by consulting scientific literature.

COURSE SYLLABUS
Medical Statistics Applied to Radiological Sciences
- Introduction to biostatistics
- Descriptive statistics
- Basic concepts of probability
- Probability distributions

Information Technology applied to Radiological Sciences
- Introduction to IT systems
- IT system hardware (CPU, memory, Input / Output)
- IT systems software: system software (operating system and utilities), application software (word processing, spreadsheets, databases, etc.)

Data Processing and Storage
1. Data Processing and Storage
- Digitization of medical images (DICOM);
- Processing workflows (acquisition → processing → storage → visualization);
- Basic concepts of memory units, files, formats, and data compression;
- Fundamentals of storage servers (PACS – Picture Archiving and Communication System).

2. Introduction to Information Systems
- Definition and role of a Hospital Information System (HIS);
- Interaction with specialized clinical systems (RIS – Radiology Information System, LIS – Laboratory Information System, etc.);
- Concepts of interoperability and healthcare standards (such as HL7, FHIR).

3. Types of Information Systems

Classification of information systems according to their function or organizational level:
- Operational systems – manage day-to-day activities (e.g., RIS);
- Managerial / Executive systems – support planning and analysis (e.g., reporting systems or data warehouses);
- Strategic / Decision Support Systems (DSS) – used for clinical analysis and research.

4. The Life Cycle of Information Systems

Covers the development and management of an information system over time:
- Requirements analysis (clinical, technical, and regulatory needs);
- Design and development;
- Implementation;
- Maintenance and updates;
- Decommissioning or replacement.

5. Database and Database Management System (DBMS)
- Difference between a database and a DBMS;
- Concepts of tables, records, primary and foreign keys, and relationships;
- Types of databases (relational, object-oriented, document-oriented);
- Applications in the healthcare domain (e.g., report databases or DICOM metadata);
- Concepts of queries, SQL, and data integrity.

Basics of Physics and Physics of Radiation
- Fundamentals of Mechanics:
  - Kinematics: Velocity and acceleration, Vectors
  - Dynamics: Force and mass, Gravitation and Newton's laws, Work and energy
- Oscillations and Waves
- Electric Charge and Electric Field
- Magnetism and Introduction to Electromagnetic Waves
- The Wave Nature of Light
- Atomic Structure and Radioactivity
- X-Rays Production and Characteristics of X-rays
- Interaction of Radiation with Matter: Photons and Electrons
- Medical Equipment for Diagnosis and Treatment
- Dosimetric Principles and Dosimetric Quantities

COURSE STRUCTURE

The integrated course of Information Technology, Statistics, and Physics Applied to Radiological Science is organized in lectures for a total of 80 hours and theoretical-practical exercises. The teachers use PowerPoint presentations to deal with the teaching topics.

COURSE GRADE DETERMINATION

The examination for the Integrated Course in Computer Science, Statistics, and Physics Applied to Radiological Sciences consists of a comprehensive assessment. During the written test, the Examination Committee will evaluate the Student's ability to apply the acquired knowledge and will ensure that the skills

meet the required learning objectives. In addition, the student's independence of judgment, communication skills, and learning ability will be assessed in accordance with the Dublin descriptors. An oral examination may be held at the discretion of the instructors.

The final exam grade will be calculated according to the following criteria:

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

18-20: barely sufficient knowledge and understanding of the topics with possible imperfections; sufficient capacity for analysis, synthesis, and autonomy of judgement.

21-23: routine knowledge and understanding of 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

READING MATERIALS

Medical Statistics Applied to Radiological Sciences

Biostatistics: A Foundation for Analysis in the Health Sciences, Daniel Wayne W. and Cross Chad L. (2013)

Information Technology applied to Radiological Sciences

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

Data Processing and Storage

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

Basics of Physics and Physics of Radiation

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

E.B Podgorsak "Radiation Oncology Physics:A Handbook for teacher and students"