COURSE CONTENT

(1) GENERAL INFO

SCHOOL	ENGINEERING			
DEPARTMENT	BIOMEDICAL ENGINEERING			
MSc PROGRAM	BIOMEDICAL ENGINEERING AND TECHNOLOGY			
STUDY LEVEL	POSTGRADUATE, MSc			
COURSE CODE	**BMET106**	**SEMESTER**	**A**	
COURSE TITLE	**Medical Signal and Image Processing**			
TEACHING			**HOURS**	**ECTS**
	LECTURES AND WORKSHOPS		26	5
COURSE TYPE	SPECIALIZATION			
COURSE REUIREMENTS:	-			
TEACHING AND EXAMINATION LANGUAGE:	ENGLISH			
IS THIS COURSE OFFER TO ERASMUS STUDENTS	YES (IN ENGLISH)			
COURSE WEBPAGE (URL)	https://eclass.uniwa.gr/courses/303/			

(2) LEARNING OUTCOMES

Learning outcomes

Course Objectives:
The aim of the course is to study the methodologies used in the creation, acquisition and processing of medical signals and medical images resulting from various medical signal generation systems (e.g. cardiogram, myogram, encephalogram) and images (e.g. digital images of MRI, CT, ultrasound, digital angiography, mammography, nuclear medicine, microscopy). Methods of data formation and storage (signals and images), methods of data imaging, as well as methods of data processing will be analysed. Data processing and analysis algorithms will be developed in theory and implemented in programming language. Students will be trained to design and implement in software integrated systems for acquisition, storage, processing, and analysis of medical signals and images using modern software libraries.

Learning Outcomes:
After the end of the course students:

1. Will know the theory and implementation technologies of methodologies related to the acquisition, imaging, processing and analysis of medical signals and images,
2. Will understand the methods used in modern computing systems of medical systems and images,
3. Will be able to distinguish and understand the processing and analysis methods required in the different cases of medical systems,
4. Be able to implement digital signal and image processing algorithms in programming language code and to implement in programming language, using modern software technologies, integrated medical signal and image processing and analysis systems.

Achievement of Course Objectives and Learning Outcomes:
To achieve the above objectives, a comprehensive introduction to programming for the acquisition and visualization of medical data (signals and images) will be provided. The methods of data processing and analysis will then be analysed with a modern implementation in a programming language, also making use of functions from relevant open-source software libraries. More in-depth evaluation of the functionality and suitability in medical applications will be achieved by designing and implementing systems, in the form of group work, to solve specific issues related to medical signals or images.

General abilities
• Search, analysis and synthesis of data and information, using the necessary technologies • Adaptation to new situations • Decision-making • Autonomous work • Teamwork • Working in an interdisciplinary environment

(3) COURSE CONTENT

"Introduction to medical signal and image processing"
Definitions, basic concepts, types of medical signals and images, signal digitization, storage, medical digital systems for creating and processing medical signals and images.

"Processing of medical signals in the time domain"
Definitions, basic concepts, convolution theorem, time domain signal filtering, types of digital filters, applications to EEG, ECG, EMG signals.

"Processing of medical signals in the frequency domain"
Definitions, basic concepts, Fourier transform, design of digital filters in the frequency domain, filtering of signals in the frequency domain.

"Displaying of medical images"
Definitions, basic concepts, imaging process, image display alteration for contrast enhancement by windowing methods, by image histogram equalization.

"Processing of medical images in the spatial domain"
Definitions, basic concepts, design of digital filters in the spatial domain for noise reduction and image clarity.

"Processing of medical images in the frequency domain"
Definitions, basic concepts, design of digital filters in the frequency domain for noise reduction and for increasing image clarity.

"Algorithms for tomographic reconstruction of medical images"
Definitions, basic concepts, Fourier methods, back-projection methods, algebraic methods, applications in CT, nuclear medicine (SPECT, PET), MRI.

"Methods of synthesis and imaging of 3D medical images"
Definitions, basic concepts, segmentation/edge detection techniques, transfer and transparency functions, rendering techniques.

(4) TEACHING AND LEARNING METHODS - EXAMINATIONS

COURSE DELIVERY	Physical presence, face to face at the auditorium or at the laboratory
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES	The theoretical part of the course is conducted with a projector (for the presentation of basic theory) and on the blackboard. The laboratory part of the course is carried out in the laboratory and includes the implementation of algorithms in a programming language.
TEACHING ORGANIZATION	

Activity	*Semester workload*
Teaching / lectures	26
Lecture material study	30

	Unsupervised literature review and preparation of the final project	69
	Total	***125***
STUNDET EVALUATION	60% final examination with problem-solving questions 20% by individual written work with code 20% by group work written in code	

(5) SUGGESTED LITERATURE

Books, scientific articles and related scientific resources:

[1] Charbit M. " Digital signal processing with python programming" (2016)
[2] Chityala R and Pudipeddi S. " Image processing and acquisition using python", CRC Press (2014)
[3] Gazi O. "Understanding digital signal processing ", Springer (2018)
[4] Gonzalez RC, Wintz P “Digital image processing” Addison-Wesley, 1977.
[5] Jain A.K. "Fundamentals of digital image processing". Prentice Hall (1989).
[6] Kinser J.M. "Image Operators: image processing in python”, Taylor & Francis Group, LLC (2019)
[7] Lynn PA and Fuerst W, “Digital signal processing with computer applications” John Wiley @ Sons 1990.
[8] Oppenheim AV and Schafer RW “Digital signal processing” Prentice Hall, 1975.
[9] Pratt W.K. "Digital image processing ". Wiley (1978).
[10] Proakis JG and Manolakis DG, “Introduction to digital signal processing” MacMillan 1988.
[11] Rogers D.F. "Procedural elements for computer graphics", McGraw-Hill (1985).
[12] Rosenfeld A. and Kak A.C. "Digital picture processing" 2nd Edition. Academic Press (1982).
[13] Stanley WD, Dougherty GR, Dougherty R, “Digital signal processing”, Prentice Hall 1984.
[14] Stearns SD, David RA “Signal processing algorithms”, Prentice Hall, 1988.

Scientific journals:

[1] Biomedical Signal Processing and Control, https://www.sciencedirect.com/journal/biomedical-signal-processing-and-control.
[2] Biomedical Signal and Image Processing, https://ieeexplore.ieee.org/document/5783430.
[3] Computer Methods and Programs in Biomedicine, https://www.sciencedirect.com/journal/computer-methods-and-programs-in-biomedicine.
[4] Computers in Biology and Medicine, https://www.sciencedirect.com/journal/computers-in-biology-and-medicine.