COURSE OUTLINE

(1) GENERAL

SCHOOL	**of SCIENCE AND ENGINEERING**		
ACADEMIC UNIT	**MATERIALS SCIENCE AND TECHNOLOGY**		
LEVEL OF STUDIES	**POSTGRADUATE**		
COURSE CODE	**TAO - 103**	**SEMESTER**	**1**
COURSE TITLE	**WAVES AND TISSUE**		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g., lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	4	7
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	general background
PREREQUISITE COURSES	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English
IS THIS COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.
Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

Upon successful completion of the course, students will be able to:

- Know the basic principles governing wave propagation in homogeneous and heterogeneous media.
- Know the basic principles and methods of wave generation and detection
- Know the techniques that allow us to control the deposition of wave energy from the source to the target

- Know the basic principles governing the interaction of waves with tissue and have first contact with their applications in medicine.
- Get to know the principles of operation of imaging optical systems.
- To be able to autonomously describe and solve wave propagation problems

The course according to the European Qualifications Framework for Lifelong Learning belongs to level 7.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations Decision-making	*Respect for difference and multiculturalism*
Working independently Teamwork	*Respect for the natural environment*
Working in an international environment	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Working in an interdisciplinary environment Production of new research ideas	*Criticism and self-criticism*
	Production of free, creative and inductive thinking .....
	Others...
	.....

- Capacity to address complex problems.
- Development of scientific thought
- Use of the University Library and multiple bibliographic references
- Searching sources, simulations, and electronic courses on the internet
- Taking notes and development of independent methods of studying
- Writing research reports
- Efficient management of time and deadlines
- Development of the ability to present concepts in a succinct form

(3) SYLLABUS

2) Fundamentals

Waves (elastic/sound, E/M radiation), *Longitudinal/Transverse (Polarization), Wave superposition*

a) **Sources of radiation**

Incoherent: Black body radiation, incandescent, arc, spectral gas, fluorescence lamps, LEDs, *X-rays*

Coherent/ Partially Coherent: Lasers (Continuous -Pulsed), Laser Types - Medical lasers*, Ultrasound*

b) **Detection of Radiation**

The photoelectric effect, photomultipliers, photoresistors, photodiodes, phototransistors, CDD detectors, film, Photometry – Radiometry, Radiant- Luminus flux, intensity, emittance. Illumination - Irradiance

3) Energy Delivery

Homogeneous/inhomogeneous media, *Absorption, Scattering*
Basic principles of wave propagation: *Diffraction, Abberations*
Energy delivery Systems
Optical Systems

Geometrical Optics: Lenses-Mirrors, simple optical systems, Aberrations
Structured waves: Wavefront sensing, Adaptive optics, Wavefront shaping, SLMs
Wave propagation in inhomogeneous/turbid media: Radiative transport equation, Diffusion theory, Transport mean free path

4) Wave-tissue interaction

Fundamentals of wave matter interaction

Electronic states, Jablonski diagram, Radiative and non-radiative transitions, Fluorescence, phosphorescence, Absorption, single vs multi-photon, Absorption spectrum, The effect of pulse duration, Thermal, non-thermal, and combined thermal and non-thermal effects, Temporal dynamics

Sub threshold processes**:**

Photodynamic therapy (PDT), Photothermal therapy (PTT)

Destructive processes:

Surgery, Dental lasers, Lasers in Ophthalmology, Ultrasound

(4) TEACHING and LEARNING METHODS - EVALUATION

Delivery *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of slides • Videos with demonstration/understanding experiments. • Use of Demonstration experiments • Use of an asynchronous e-learning platform (e-class) where the following are provided: o *Bibliography of the course* *o Slides of the course* *o Solved and unsolved exercises* *o Self-study Exercise Set* *o Lecture videos*[*] *o Demonstration videos and simulations* *o* Communication through the e-class platform, use of the discussion area facility with topics, email as well as fixed office hours announced • Students' assignments are received and corrected via the platform (e-class)
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching,*	

Activity	***Semester workload***
Lectures	52
Assignments/Projects	30
Directed learning activity (office hours)	26
Non-directed learning activity	66
Course total	***174***

educational visits, project, essay writing, artistic creativity, etc. *The student's study hours for each learning activity are given as well as the hours of non- directed study according to the principles of the ECTS*	<table><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple-choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically defined evaluation criteria are given, and if and where they are accessible to students.*	Language of Evaluation: English The final grade is the sum of 40% of the average of the grades of the weekly assignments 30% of the average of the grades of the weekly written tests 30% of the grade of the final written examination

(5) ATTACHED BIBLIOGRAPHY

Bibliography-

- *Lecture notes*
- *"Optics", E. Hecht, Addison-Wesley, (2001).*
- *“Laser-Tissue Interactions”, by Markolf H. Niemz (Springer International Publishing), 4th Edition (2019)*
- *Introduction to Modern Optics, by Grant R. Fowles (Dover Books on Physics) 2nd ed. Edition,*

Bibliography: exercises with solutions

- *Solved exercises in Waves and Tissue interactions”, D. Papazoglou, UoC, (2024).*