COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF ELECTRONICS ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	8002004	**SEMESTER**	2
COURSE TITLE	Wireless and Optical Communications		

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 (ECTS)**
Lectures	4	9
E-learning	2	
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*	Scientific Area
PREREQUISITE COURSES:	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek and English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://optcomm.teipir.gr/

(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 this course, the students possess advanced knowledge, skills and competences that enable them to:

(In relation to the field of Wireless Communications:)

- Describe the basic wireless propagation mechanisms and explain the relevant signal attenuation and/or distortion phenomena.
- Apply design and measurement rules for the basic types of wireless communication air channels.
- Analyze and perform calculations with respect to the operational and performance characteristics of the digital modulation and channel coding techniques used in wireless communications.

- Describe the operational principles of the spread spectrum, OFDM and MIMO techniques as well as perform basic calculations regarding their operation and performance.
- Describe the Physical layer specifications of modern wireless communication networks.

(In relation to the field of Optical Communications:)

- Understand, state and explain the basics of the optical network components (optical sources, fibers, receivers, etc.).
- Understand, explain by drawing diagrams and be able to analyze and design basic optical fiber network topologies (point to point, ring, star and bus).
- Know and explain by drawing diagrams the characteristics and operation principles of WDM technology.
- Analyze specifications and design an optical WDM network topology.
- Understand, state and explain the basic principles of control and management of an optical network.
- Understand and explain by drawing diagrams the passive optical network technologies (PON); be able to design an access network with specific optical components.

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	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Working independently
- Team work
- Production of free, creative and inductive thinking

(3) COURSE CONTENT

The wireless communication course part deals with advanced topics concerning the wireless propagation phenomena and the relevant channel modeling as well as topics dealing with the transmission and channel coding techniques implemented on the air interface of modern wireless communication networks. In this context, the following topics are covered:

- Electromagnetic wave propagation mechanisms: free space propagation, reflection and transmission at media boundaries, diffraction, scattering.
- Wireless Propagation Phenomena:
- Atmospheric Phenomena: atmospheric refraction, attenuation due to rain and atmospheric gases.

- Ground Phenomena: shadowing and multipath fading.
- Modeling and design of specific radio links: a) Terrestrial Line of sight Links, b) Earth Space Satellite Links, c) Terrestrial Land Mobile Cellular Links, d) Indoor Wireless Communication Links.
- Digital modulation and channel coding for error detection and correction.
- Spread Spectrum, OFDM and MIMO transmission techniques.
- Modern Radio Access Networks (RAN):
    - Cellular 3G-4G-5G RANs
    - IEEE 802.16/WiMAX RANs
    - IEEE 802.11/WiFi RANs
    - IEEE 802.15/WPAN RANs

The optical communications part covers design and operation aspects of local area networks and backbone high capacity networks. The following topics are covered:

- Optical fibers and components
- Basics of wavelength division multiplexing (WDM) optical networks
- Design of WDM optical networks
- Control and management of optical networks
- Access networks and passive optical networks

In particular, the course module lectures are organized in ten (10) teaching units where the parts related to wireless and optical communications are taught in parallel.

The Wireless Communication part is organized in five (5) topics:

Unit 1	3 x 2h Lectures	**Electromagnetic wave propagation mechanisms** Free space propagation, propagation through reflection or transmission at media boundaries as well as propagation through diffraction and scattering is analyzed. Furthermore, atmospheric phenomena including atmospheric refraction and the consequences regarding line of sight as well as rain and gas attenuation and their role in link budget calculations are discussed. Finally, shadowing and multipath fading phenomena are discussed and with emphasis on the relevant calculations.
Unit 2	3 x 2h Lectures	**Radio Link Modeling and Design** This teaching unit deals with the combined presence of different propagation phenomena for the following types of radio links: a) Terrestrial Line of sight Links, b) Earth Space Satellite Links, c) Terrestrial Land Mobile Cellular Links, d) Indoor Wireless Communication Links. Emphasis is given on the different installation choices, the link budget calculations as well as on the availability/coverage calculations for each of the aforementioned radio link types.
Unit 3	3 x 2h Lectures	**Digital Modulation and Coding Techniques for Error Correction** Teaching Unit 3 presents the baseband transmission techniques that are used in wireless communications. In particular, digital modulation techniques such as FSK, PSK and QAM are discussed. Furthermore, the basic operation principles of the block and convolutional error detection and correction techniques are presented.

Unit 4	3 x 2h Lectures	**Spread Spectrum, OFDM and MIMO transmission techniques** Spread Spectrum (Frequency Hopping and Direct Sequence Spread Spectrum) OFDM and MIMO transmission techniques are discussed as technical solutions aiming to improve wireless communication channel capacity and performance.
Unit 5	2 x 2h Lectures	**Modern Radio Access Networks (RAN)** In this teaching unit the specific combination of techniques that essentially implement the physical layer on the air interface of the modern radio access networks is discussed. In this context the following types of RANs are examined: a) Cellular 3G-4G-5G RANs, b) IEEE 802.16/WiMAX RANs, c) IEEE 802.11/WiFi RANs και d) IEEE 802.15/WPAN RANs.

The optical communications part is divided in five (5) topics:

Unit 1	4 x 2-h lectures	**Optical fibers and optical network components** A detailed review of the basic optical network components. Specifically, the courses focus on the characteristics of optical fibers, laser sources and receivers, as well as the other components like optical filters, modulators, optical fiber-amplifiers, multiplexers and demultiplexers, etc.
Unit 2	2 x 2-h lectures	**Basics of wavelength division multiplexing (WDM) optical networks** Analysis of characteristics and implementation of wavelength division multiplexing (WDM) network topologies. Classic (coarse) and advanced (dense) multiplexing as well as the corresponding components for interconnection and data add/drop (OADM).
Unit 3	1 x 2-h lectures	**Design of WDM optical networks** Design of wavelength routing networks. Dimensioning and study of various topologies.
Unit 4	1 x 2-h lectures	**Control and management of optical networks** Network management functions. Optical layer services and interfacing. Layers within the optical layer. Network survivability.
Unit 5	2 x 2-h lectures	**Access networks and passive optical networks** Principles of access networks with focus on passive optical networks (PONs) and FFTx applications.

Along with the theory lectures, students attend practice sessions in the lab.

The wireless communication exercises include: α) simulation models and laboratory measurements relevant to electromagnetic wave propagation phenomena, b) Simulation of transmission and channel coding techniques (digital modulation, Forward Error Correction, Spread Spectrum and OFDM transmission techniques) and c) radio measurements in cellular radio access networks (3G-4G coverage and voice/data service measurements).

In the optical communications part, a commercial software simulator for optical links is used.

Furthermore, students familiarize and practice in optical fiber handling and measurements (fiber splicing, OTDR measurements).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	• Face to face lectures in class • E-learning
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of electronic presentation with multimedia content in class, • Student support through the course webpage and the departmental e-learning platform (moodle), • Electronic communication of instructors and students, through the course webpage and by e-mail.
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, 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*	Lectures, lab practice, homework assignments / project, study.
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.*	Student performance will be evaluated through: • Interim written examination on the theoretical part. • Final written examination on the theoretical part. • Combination of oral examination and class presence with project report. • Laboratory skills.

Activity	***Semester workload (hours)***
Lectures	52
E-learning	26
Study lecture material	52
Lab practice	26
Report on lab practice	26
Homework assignments or project and report (individual or group)	50
Study and preparation for the exams	36
Visit a company / production plant / institution	2
Course Total	**270**

(5) ATTACHED BIBLIOGRAPHY

-Recommended Books

Wireless Communication Part

1. Molisch, A., Wireless Communications, 2nd Ed, Willey, 2010.
2. Rappaport, T.S., Wireless Communications: Principles & Practice, 2nd Ed. Prentice Hall, 2010.
3. Bertoni, H.L., Radio Propagation for Modern Wireless Systems, Prentice Hall, 2000.
4. Saunders, S. R., Antennas and Propagation for Wireless Communication Systems, John Wiley & Sons, 1999.
5. Tse D. and Viswanath P., Fundamentals of Wireless Communications, Cambridge University Press, 2005.
6. Prasad, R., OFDM for Wireless Communications Systems, Artech House, 2004.

Optical Communications Part

1. RAMASWAMI, R. and SIVARAJAN, K., *Optical Network,* Elsevier 2002.
2. GREEN, P., *Optical Fiber Networks*, Papasotiriou 1994.
3. AGRAWAL, G.P. *Optical Fiber Communication Systems,* Tziolas 1997.
4. GOWAR, J., *Optical communication systems,* Prentice Hall 1993.
5. PALAIS, J.C., *Fiber optics communications* Prentice Hall 2005.