

## COURSE OUTLINE

### (1) GENERAL

|   |   |                              |                |
|---|---|------------------------------|----------------|
| <b>SCHOOL</b>   | ENGINEERING   |                              |                |
| <b>ACADEMIC UNIT</b>  | ELECTRICAL AND COMPUTER ENGINEERING DEPT.                                       |                              |                |
| <b>LEVEL OF STUDIES</b>   | Undergraduate   |                              |                |
| <b>COURSE CODE</b>  | <b>ECE_TEL760</b>   | <b>SEMESTER</b>              | <b>7</b>       |
| <b>COURSE TITLE</b>   | <b>FIBER OPTIC NETWORKS</b>   |                              |                |
| <b>INDEPENDENT TEACHING ACTIVITIES</b><br><i>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</i> |   | <b>WEEKLY TEACHING HOURS</b> | <b>CREDITS</b> |
| Lectures  |   | 2                            |                |
| Seminars / Practice exercises   |   | -                            |                |
| Laboratory  |   | 2                            |                |
| <i>Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).</i>  |   | 4                            | 5              |
| <b>COURSE TYPE</b><br><i>general background, special background, specialised, general knowledge, skills development</i>   | specialised   |                              |                |
| <b>PREREQUISITE COURSES:</b>  | No. Students are advised to have already attended the course: COMPUTER NETWORKS |                              |                |
| <b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b>  | Greek   |                              |                |
| <b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b>  | Yes   |                              |                |
| <b>COURSE WEBSITE (URL)</b>   | <a href="https://www.ece.uop.gr/">https://www.ece.uop.gr/</a>                   |                              |                |

### (2) LEARNING OUTCOMES

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| <p><b>Learning outcomes</b></p> <p><i>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.</i></p> <p><i>Consult Appendix A</i></p> <ul style="list-style-type: none"> <li>• <i>Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</i></li> <li>• <i>Descriptors for Levels 6, 7 &amp; 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</i></li> <li>• <i>Guidelines for writing Learning Outcomes</i></li> </ul> <p>The course specializes in the engineering field of fiber optic communications and fiber optical networks. It aims to deliver the basic principles of digital communications thru optical fibers specifically studying the optical fiber as a cylindrical waveguide, analyzing the electro-optic &amp; opto-electronic conversions in semiconductors and optical transmission – propagation – reception in fiber optic links. Then it proceeds to study and analyze specific fiber-optic technology issues such as optical coupling, optical multiplexing, optical amplification, transmission characteristics and quality, receiver noise, attenuation and dispersion, compensation techniques, bit-error-rate/BER, etc. Finally modern optical technologies such as metro-optical networks infrastructure and present-day subscriber services (triple-play) are discussed comprehensively.</p> <p>At the end of the course the student would also develop several additional skills such as:</p> <ul style="list-style-type: none"> <li>- A deep theoretical and practical ability to cope with fiber optic communications and optical fiber modern networking systems. He 'll be able to conceive the course philosophy, understand the nature &amp; operation of fiber optics and learn how present-day data-voice communication and</li> </ul> |
|---|

context/entertainment subscriber services are implemented with the use of this technology-of-excellence.

- A good knowledge basis in designing, configuring and handling/testing basic fiber optic communication systems in a simulated environment.
- An early experience in the design and simulated development and testing of a complex fiber optic communication infrastructure before the real-world field installation.

### 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?*

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

- Search for, analysis and synthesis of data and information, with the use of the necessary theoretical concepts, terms and technology
- Adapting to new situations
- Decision-making
- Working independently
- Team work
- Critical thinking development
- Inductive thinking development
- Ability to make an idea work thru implementation
- Develop skills for applied research

### (3) SYLLABUS

Theoretical course consists of the following chapters:

- Brief review of basic principles and facts in digital communication.
- Introduction to fiber optic communication. History and evolution.
- Geometrical / Ray optics. Basic principles of optoelectronics.
- Basics of fiber optic communication according to waveguide theory. A cylindrical optical fiber waveguide. Transmission characteristics and technology. Attenuation and dispersion. Linear and non-linear phenomena.
- Multimode and monomode optical fibers. Silica, fluoride glass & hollow-core fiber technologies.
- Electro-optical conversion in semiconductors. Optical transmitters (LED, Laser). Optical transmitter driver circuit technologies.
- Opto-electronic conversion in semiconductors. Optical receivers (pin, APD). Low-noise optical preamplifier technologies and circuits.
- Fiber optic links for data transmission.
- Fundamentals of optical couplers and optical modulators. Optical multiplexing (WDM) & dense multiplexing (DWDM). Optical amplification.
- Fiber optical Link Budget
- Optical time domain reflectometry. Fault location techniques.
- Metro-optical networks. Wide area networking fiber optic rings. Long-haul wideband optical links.
- Broadband subscriber services.

The laboratory course consists of nine specific exercises on an Fiber Optical Simulator Platform namely OptSim v4.6 by Synopsys. The simulator employs monomode fiber optics operating at 1,55 $\mu$ m very long wavelength window. Simulation results can be monitored/saved by means of simulated oscilloscopes, optical spectrum analyzers, eye diagrams, bit-error-rate/BER testers etc. All fiber link characteristics, variables and parameters can be configured in order for the link to be tested as far as its quality and performance are concerned

The exercises are the following:

- Exercise 1. Introduction to RSoft OptSim v4.6 (now offered by Synapsys)

- Exercise 2. Optical transmitter analysis in a fiber optic communication system
- Exercise 3. Optical fiber attenuation analysis in a fiber optic communication system
- Exercise 4. Optical fiber chromatic dispersion analysis in a fiber optic communication system
- Exercise 5. Optical receiver. Photodetector, low-noise optical preamplifier, filter. Study and analysis.
- Exercise 6. 10 Gbps Fiber optic Link Budget
- Exercise 7. Optical multiplexing (WDM, DWDM)
- Exercise 8. Metro-optical networks. Analysis of an urban optical ring with ADD/DROP multiplexers/demultiplexers
- Exercise 9. Triple-Play subscriber service in GPON 10GBASE optical Ethernet

#### (4) TEACHING and LEARNING METHODS - EVALUATION

| <b>DELIVERY</b><br><i>Face-to-face, Distance learning, etc.</i>   | Face-to-face   |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
|---|--|-----------------|--------------------------|----------|-----------|---------------------|-----------|----------|----|---------------------|---|------------------|---|---------------------|----------------------------|
| <b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b><br><i>Use of ICT in teaching, laboratory education, communication with students</i>   | <ul style="list-style-type: none"> <li>▪ Power Point presentations.</li> <li>▪ Laboratory exercises textbook. Available in typed and electronic form. (<a href="http://www.microlab.uop.gr">http://www.microlab.uop.gr</a> &amp; <a href="https://eclass.pat.teiwest.gr/">https://eclass.pat.teiwest.gr/</a>)</li> <li>▪ Further digital learning &amp; educational/training material such as: exercises, presentations, scientific papers, white papers, older exam solutions &amp; problems solved for theory and lab, announcements, student registration &amp; mail service, alerts, statistics, other educational services, etc. (<a href="http://www.microlab.uop.gr">http://www.microlab.uop.gr</a> &amp; <a href="https://eclass.pat.teiwest.gr/">https://eclass.pat.teiwest.gr/</a>)</li> </ul>   |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
| <b>TEACHING METHODS</b><br><br><i>The manner and methods of teaching are described in detail.</i><br><br><i>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.</i><br><br><i>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</i>               | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;"><b>Activity</b></th> <th style="text-align: center;"><b>Semester workload</b></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Lectures</td> <td style="text-align: center;">2 x 13=26</td> </tr> <tr> <td style="text-align: center;">Laboratory practice</td> <td style="text-align: center;">2 x 13=26</td> </tr> <tr> <td style="text-align: center;">Homework</td> <td style="text-align: center;">67</td> </tr> <tr> <td style="text-align: center;">Final exam (theory)</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">Final exam (lab)</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;"><b>Course Total</b></td> <td style="text-align: center;"><b>125 ώρες<br/>5 ECTS</b></td> </tr> </tbody> </table> | <b>Activity</b> | <b>Semester workload</b> | Lectures | 2 x 13=26 | Laboratory practice | 2 x 13=26 | Homework | 67 | Final exam (theory) | 3 | Final exam (lab) | 3 | <b>Course Total</b> | <b>125 ώρες<br/>5 ECTS</b> |
| <b>Activity</b>   | <b>Semester workload</b>   |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
| Lectures  | 2 x 13=26  |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
| Laboratory practice   | 2 x 13=26  |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
| Homework  | 67   |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
| Final exam (theory)   | 3  |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
| Final exam (lab)  | 3  |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
| <b>Course Total</b>   | <b>125 ώρες<br/>5 ECTS</b>   |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |
| <b>STUDENT PERFORMANCE EVALUATION</b><br><br><i>Description of the evaluation procedure</i><br><br><i>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</i><br><br><i>Specifically-defined evaluation criteria are given, and if and where they are accessible to</i> | <p>Language: Greek</p> <p>Evaluation:</p> <p>(a) Final written examination in theory. It includes all educational material described in (3)</p> <p>(b) Written and/or practical examination in every laboratory exercise. A weekly student assessment method for every laboratory exercise in being applied by means of an obligatory homework evaluation scheme for each student. All students prepare and deliver reports for every exercise, based in their simulation results &amp; associated reasoning. In addition a practical final exam may be applied.</p>   |                 |                          |          |           |                     |           |          |    |                     |   |                  |   |                     |                            |

students.

Final grade= $0,6x(a) + 0,4x(b)$   
The whole evaluation procedure and criteria are known to all students.

## (5) ATTACHED BIBLIOGRAPHY

1. Fiber-Optic Communication Systems 4th Edition by Govind P. Agrawal
2. The FOA Reference Guide to Fiber Optic Network Design: Study Guide For FOA Certification Kindle Edition, by Jim Hayes (Editor), Bee Suat Lim (Preface) 2016
3. Next Generation Intelligent Optical Networks: From Access to Backbone, Stamatios Kartalopoulos, Springer-Verlag US 2008.
4. Fibre Optic Communication Key Devices. Expanded, updated and revised new edition, Editors: Venghaus, Herbert, Grote, Norbert (Eds.), Springer International Publishing 2017.
5. Optical fiber communications: Principles and practice J. M. Senior, Prentice Hall, 2008.
6. Optical Fiber Transmission Systems (Applications of Communications Theory) 1981st Edition by Stewart D. Personick, Springer, 1981.
7. Fiber Optics: Technology and Applications (Applications of Communications Theory) 1985th Edition, by Stewart D. Personick, Springer, 1985.
8. Fiber Optic Networks 1st Edition by Paul E. Green
9. G. Keiser, Optical fiber communication, McGraw-Hill, 1983.

### Περιοδικά

- IEEE/OSA Journal of lightwave technology, vol.26, no. 9, May 1, 2008, Optical Detectors and Receivers Stewart D. Personick, Fellow, IEEE, Fellow, OSA, Invited Paper
- IEEE/OSA Journal of Optical Communications and Networking
- Optical Fiber Technology, Elsevier
- Journal of Optical and Fiber Communications Research, Springer