# UNIVERSITÀ DEGLI STUDI DI PALERMO

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| **DEPARTMENT** | Ingegneria |
| **ACADEMIC YEAR** | 2018/2019 |
| **MASTER'S DEGREE (MSC)** | ELECTRONIC ENGINEERING |
| **SUBJECT** | OPTOELECTRONICS |
| **TYPE OF EDUCATIONAL ACTIVITY** | B |
| **AMBIT** | 50364-Ingegneria elettronica |
| **CODE** | 09078 |
| **SCIENTIFIC SECTOR(S)** | ING-INF/01 |
| **HEAD PROFESSOR(S)** | BUSACCA ALESSANDRO Professore Ordinario Univ. di PALERMO |
| **OTHER PROFESSOR(S)** | |
| **CREDITS** | 6 |
| **INDIVIDUAL STUDY (Hrs)** | 102 |
| **COURSE ACTIVITY (Hrs)** | 48 |
| **PROPAEDEUTICAL SUBJECTS** | |
| **MUTUALIZATION** | |
| **YEAR** | 1 |
| **TERM (SEMESTER)** | 1° semester |
| **ATTENDANCE** | Not mandatory |
| **EVALUATION** | Out of 30 |
| **TEACHER OFFICE HOURS** | **BUSACCA ALESSANDRO**<br>Monday 16:00 18:00 Laboratorio U 330 |

**DOCENTE:** Prof. ALESSANDRO BUSACCA

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| **PREREQUISITES** | Good knowledge of the analysis techniques for lumped parameters circuits for sinusoidal and pulsed regime, that students have acquired in the Electrotechnics course. Good knowledge of vector calculus and phasors. Basic knowledge of differential and integral calculus. Notions of Mathematics, Physics I and II |
| **LEARNING OUTCOMES** | Knowledge and comprehension capacity<br>At the end of the course, the student will have acquired:<br>•knowledge of propagation phenomenon in standard and special optical fibres;<br>•in deep knowledge of the optical channel;<br>•a good knowledge of the state of the art;<br>•a particular comprehension on the use of electronics and electromagnetism in the optical communications;<br>•the useful tools for the design and test of an optical link;<br>• a complete and thorough understanding on multiplexing, amplification, modulation, receiving and transmission of optical signals;<br>•will be aware of the multidisciplinary scientific context that embraces the fields of Electronics and Telecommunications.<br><br>Ability to apply the acquired knowledge<br>The student will be able to:<br>•recognize the optical modulation formats and the optical channel capacity;<br>•apply the analytical tools of electromagnetism, electronics, electronic systems and numerical transmissions to real problems related to optical communication;<br>•design of optical communication channels;<br>•measure and test optical communication systems;<br>•develop problem solving abilities in particular in the case of a network failure and in the design of an optical channel starting from the customer needs;<br>• develop the ability to use their knowledge and understanding of models, systems and channels, and optical networks;<br>• develop the ability to apply innovative methods and propose novel configurations on the basis of the state of the art;<br>• develop the ability to use their knowledge, understanding and creativity to design new and original systems, architectures and components for optical communications.<br><br>Ability to evaluate scenarios<br>The student will be able to:<br>• develop their knowledge even in the absence of appropriate and complete technical specifications;<br>• to identify, locate, quantify and interpret through appropriate measures the optical and electro-optical quantities;<br>•to design and independently evaluate, starting from the available budget and the requests of the client, an optical communication system;<br>•to establish independently the components more appropriate with respect to the performance required by the customer;<br>•to investigate the application of emerging technologies in the field of optical communications, in particular with reference to integrated optical components and special optical fibre;<br>• develop the ability to integrate the knowhow from photonics and telecommunications and to manage complexity;<br>•have a deeper understanding of photonic techniques and their limits.<br><br>Communication skills<br>The student will be able to:<br>•acquire the ability to communicate issues concerning optical communications in Italian and English;<br>• know the physical quantities and terminology of Optical Communications in Italian and English;<br>• will be able to hold conversations on current issues affecting the broadband communication in Italian and English;<br>• use different methods to communicate effectively with colleagues and in particular with engineers during workshops and through oral presentations with or without the use of presentation software;<br>•to discuss properly with optical communications specialist and with colleagues; to release technical guidelines; to manage groups of engineers and also communicate with non-experts;<br>• to manage a team also not purely technical, and composed of competent persons in various disciplines at different levels both in a national context and in an international one;<br>•to produce reports and disseminate scientific knowledge.<br><br>Learning ability<br>The student will be able to:<br>•develop autonomous learning;<br>• carry out bibliographic research independently on topics of optical communications; |

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| | • to autonomously read a specialized document in Italian and English and understand it;<br>• to attend seminars and workshops and understand oral reports and proceedings;<br>•acquire the ability to study and produce results autonomously;<br>•extract important information in the field of optical communication and separate it from the useless one. |
| **ASSESSMENT METHODS** | Midterm examinations or Written final exam, Oral examination<br>The learning evaluation will be carried out by means of midterm examinations all along the course duration and a final oral examination. The midterm examination will deal with topics covered during the course. Alternatively, the student that will not reach a sufficient score (minimum 18 out of 30) in the midterm examinations, will have to take a written examination that will also deal with topics covered during the course. Also in this case, the minimum score needed to pass the written test will be 18 out of 30.<br>The final oral examination consists in the request to the student to discuss some topics covered during the course by the teacher. For each topic, the student will first have to contextualize the subject within the course, describe its meaning and importance, for example by means of formal definitions and scope of applications, and define the study methods and eventually the validity limits. Finally, the student will have to discuss the topic by a correct use of language and a fluent analytical treatment. The aim of the final examination will be to evaluate whether the student has a good knowledge and comprehension of basic integrated optical components and circuits, optical communication systems and of their potential applications<br>in the field of ICT. At the end of the exam, the examination committee informs the student whether he/she has passed the exam. If the examination has been passed, the committee gives the final result to the student based on the following evaluation criteria: a) level of knowledge of the topics discussed during the oral examination, and the capacity of autonomously interconnecting such topics to other covered during the course (90% of the final grade); b) obtained level in the capacity of expressing correctly in the technical language of the subject (10% of the final grade).<br><br>The exam consists in three questions, posed orally, on the topics of the course syllabus.<br>The exam is designed to test the acquired knowledge, the planning and solving ability, the presentation skills and the use of appropriate technical language of the student.<br>The assessment is based on the following grades:<br>a) excellent (30-30 cum laude): excellent knowledge of the topics, excellent use of technical language, good analytical ability, ability to apply knowledge to solve the proposed problems;<br>b) very good (26-29): good knowledge of the topics, good use of technical language, ability to apply knowledge to solve the proposed problems;<br>c) good (24-25): basic knowledge of the main topics, discrete use of technical language, limited ability to independently apply the knowledge to the solution of the proposed problems;<br>d) satisfactory (21-23): not full grasp of the main teaching topics, satisfactory use of technical language, poor ability to independently apply the acquired knowledge;<br>e) sufficient (18-20): minimal knowledge of the main topics and basic use of technical language, very little or no ability to independently apply the acquired knowledge;<br>f) insufficient: absence of an acceptable minimum knowledge of the contents of the topics covered in the course. |
| **EDUCATIONAL OBJECTIVES** | The course will provide a solid knowledge on devices and systems for optical fiber communications. The design criteria will be illustrated together with an evaluation of the optical fiber performances with a particular emphasis on wavelength division multiplexing (WDM) systems.<br>. |
| **TEACHING METHODS** | Frontal lectures and tutorials; Laboratory tutorials |
| **SUGGESTED BIBLIOGRAPHY** | - G. P. Agrawal, Fiber-Optic Communication Systems, 2nd edition, Wiley Interscience, 1997<br>- J. Singh: Semiconductor Optoelectronics: Physics and technology, Mc-Graw-Hill, Inc. (1995)<br>- S. M. Sze, M. K. Lee: Semiconductor Devices. Physics and Technology (3rd edition), John Wiley & Sons, Inc. (2012)<br>- C. W. Wilmsen, H. Temkin, L. A. Coldren: Vertical-Cavity Surface-Emitting Lasers: Design, Fabrication, Characterization, and Applications, Cambridge University Press (2001)<br>- E. F. Schubert: Light-Emitting Diodes, Cambridge University Press (2006)<br>- D. Sands: Diode lasers, IoP Publishing (2005)<br>- S. D. Gunapala, D. R. Rhiger, C. Jagadish: Advances in Infrared |

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| | Photodetectors (Semiconductors and Semimetals, Vol. 84), Elsevier (2011)<br>- M. Henini, M. Razeghi: Optoelectronic devices: III Nitrides, Elsevier (2005) |

## SYLLABUS

| Hrs | Frontal teaching |
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| 4 | Fiber Optics |
| 4 | Dispersion in the optical channel |
| 4 | Optical losses in the optical channel |
| 2 | Nonlinear optical effects |
| 3 | Trasmettitori ottici |
| 3 | optical receiver |
| 4 | Design and test of an optical communication system |
| 4 | Multiplexing systems |
| 4 | Amplificatori ottici |

| Hrs | Practice |
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| 16 | Fibre optic coupling, fibre optical modes, photodetector |