Universidad de Alcalá

TEACHING GUIDE

Photonic Technology

Master in
Telecommunication Engineering

Universidad de Alcalá

Academic Year 2021/2022

1st Year - 2nd Semester

Approved by the School Board on July 6, 2021

TEACHING GUIDE

Course Name:	**Photonic Technology**
Code:	**201814**
Master in:	**Telecommunication Engineering**
Department and area:	**Electrónica** **Tecnología Electrónica**
Type:	**Compulsory**
ECTS Credits:	**3.0**
Year and semester:	**1st Year, 2nd Semester**
Teachers:	Sonia Martín López
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	Spanish / English Friendly

1. COURSE SUMMARY

The Photonics Technology module aims to give to the student the background required to understand and develop application systems based on optoelectronics devices. These hybrid systems, based on both electronic and photonic systems, are nowadays the building blocks of several novel technologies with applications in monitoring, telecommunications and sensing.

Students will learn about the operation principles, fabrication technologies and applications of active and passive photonic devices. A special emphasis will be done on the study of their use as transducers of external magnitudes (like temperature and strain) to optical domain.

In order to be able to benefit from this module, students must have a strong background on Optics, which can be acquired in Degree courses like Fundamentals of Physics II (350008), Waves Propagation (350022) and Photonics Technologies (370007).

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/355/2009:

en_CGT1 - Skill of analysis and synthesis.

en_CGT2 - Skill of organization and planning.

en_CGT3 - Skill to analyze and search for information from diverse sources

en_CGT4 - Skill to make decisions.

en_CGT5 - Skill to adapt to new situations.

en_CB6 - To have and understand knowledges that provide a basis or opportunity to be original in the development and/or application of ideas, often in a research context

en_CB7 - That students know how to apply the acquired knowledge and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

en_CB9 - That students be able to communicate their findings and the ultimate knowledge and reasons behind them to specialized and non-specialized audiences in a clear and unambiguous manner.

en_CB10 - That students have the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.

en_CT1 - Troubleshooting skill

en_CT3 - Skill to work in a team

en_CT4 - Working in a pressure environment

en_CT5 - Motivation for quality

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of

the Annex to the Orden CIN/355/2009:

en_CGestion1 - Ability to integrate technologies and systems typical of Telecommunications Engineering, with a generalist nature, and in broader and multidisciplinary contexts such as in bioengineering, photovoltaic conversion, nanotechnology, telemedicine.

en_CTecTel13 - Ability to design communications components, such as routers, switchers, transmitters and receiver in different bands

en_CTecTel14 - Ability to develop electronic instrumentation, as well as transducers, actuators and sensors

Upon successful completion of this course, students will be able to

RA1 To understand the fundamental principles of photonic technology.

RA2 To understand the different optoelectronic and photonic devices.

RA3 Ability to develop optoelectronic and photonic systems.

3. CONTENTS

Contents Blocks	Total number of hours
Module 0. Introduction. • Lesson 0 - Introduction of the course Photonic Technology.	1 hour
Module 1. Optical fibre • Lesson 1 - Introduction to multimode and single mode optical fibres. • Lesson 2 - Linear propagation in single mode optical fibres. Attenuation, chromatic dispersion and polarization dispersion. • Lesson 3 - Non-linear effects in single mode optical fibres.	10 hours
Module 2. Passive photonic devices and applications • Lesson 4 - Attenuators, Filters and Couplers Devices based on Faraday effect. Relevant specifications.	4 hours
Module 3. Active photonic devices and applications. • Lesson 5 - Overview of lasers and detectors. Lasers and semiconductor detectors Optical modulators. Optical amplifiers. Main specifications. • Lesson 6 - Noise in Photonic Systems and Characterization Parameters.	9 hours
Module 4. Photonic Sensors. • Lesson 7 - Application of magneto-optical, thermo-optical, electro-optical, elasto-optical and acousto-optical effects on sensor structures.	2 hours
Exhibition of practical exercises of analysis, design and experimentation of photonic systems.	2 hours
Evaluation Exercises: Individual evaluation sessions on group exercises.	2 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	30 hours (28 hours on-site +2 exams hours)
Number of hours of student work:	45
Total hours	75

4.2. Methodological strategies, teaching materials and resources

In the teaching-learning process, the following training activities will be carried out

- Theoretical and practical classes in large/small groups: presentation and discussion of the contents of each topic.

- Theoretical and practical classes in small groups: raising and solving questions and exercises. Individual evaluation activities.

- Practical classes, in small groups: laboratory sessions.

- Tutorials: individual and group.

In addition, the following additional resources, among others, may be used:

- Individual or group work: involving, in addition to its realization, the corresponding public exposure to the rest of their peers to encourage debate.

- Attendance at conferences, meetings or scientific discussions related to the subject.

Throughout the course the student will be offered activities and tasks both theoretical and practical. Different practices will be carried out so that the student can experience and consolidate the concepts acquired, both individually and in groups.

For the realization of the practices, the student will have at his disposal in the laboratory a station with basic instruments (oscilloscope, power supply, signal generator, spectrometer in the VIS-NIR range), as well as a computer with software tools for design and simulation. In this subject, it is proposed that the practices be carried out in groups of a maximum of two students.

Throughout the learning process in the subject, the student should make use of different bibliographic or electronic sources and resources, so that he or she becomes familiar with the documentation environments that will be used professionally in the future.

The teaching staff will provide the necessary materials for the monitoring of the subject (theoretical foundations, exercises and problems, practice manuals, audiovisual references, etc.) so that the student can meet the objectives of the subject, as well as achieve the expected skills.

Throughout the four-month period, the student will have programmed group and individual tutorials according to his/her needs. Whether individually or in small groups, these tutorials will help to resolve doubts and consolidate the knowledge acquired. In addition, they will help to monitor students and evaluate the proper functioning of the teaching-learning mechanisms.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines (last modified in the Governing Board of October 31, 2019) as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Preferably, students will be offered a system of continuous assessment that has formative assessment characteristics so that it serves as feedback in the teaching-learning process. of formative assessment so that it serves as feedback in the process of teaching and learning by the student.

The assessment must be inspired by the criteria of continuous assessment (Learning Assessment Regulations, NEA, art 3). However, in accordance with the regulations of the University of Alcalá, an alternative final assessment process is an alternative process of final assessment is available to the student in accordance with the Regulations for the Assessment of Learning (last modified in the Governing Council of 31 October 2019) as indicated in its Article 1. 2019) as indicated in Article 10, students will have a period of fifteen days from the beginning of the course to request in writing to the Director of the of the course to request in writing to the Director of the Higher Polytechnic School their intention of the non-continuous assessment model, stating the reasons they deem appropriate. The assessment of the learning process of all students who do not submit a request or whose request is denied will be carried out The assessment of the learning process of all students who do not apply for it or whose application is denied will be carried out, by default, in accordance with the continuous assessment model. The students have two examinations to pass the course, one ordinary and one extraordinary.

EVALUATION CRITERIA

The evaluation process aims to assess the degree and depth of the student's acquisition of the competencies described in section 2.

Accordingly, the evaluation criteria applied in the various tests that are part of the process will ensure that the student has the appropriate level

in the following knowledge and skills:

CE1 Advanced knowledge of the properties of photonic devices used in systems that incorporate light radiation as an information carrier

CE2 Advanced knowledge of the linear and non-linear properties of optical fibre and its applications.

CE3 To identify the different photonic devices available in the market and apply them to the solution of problems of design of experimental schemes.

CE4 Knowledge of the different mechanisms of photonic transduction and their application for the development of complex sensory systems with specific requirements

CE5 Ability to provide a reasoned justification for the steps and stages followed in solving problems of analysis and synthesis of systems involving photonic devices

CE6 Ability to document and argue, adequately and reasonably, the theoretical/practical work done.

5.2. EVALUATION

EVALUATION PROCEDURE

In accordance with the above criteria (especially items 2, 3 and 6), the performance of experimental laboratory practices is an essential element for the acquisition of the target competencies of the subject.

Consequently, attendance at the laboratory sessions and passing the obligatory practices will be considered an essential element of the evaluation, both in the ordinary and the extraordinary call, and in the two forms of evaluation foreseen: continuous and non-continuous.

Likewise, given that passing the evaluation criteria established for the laboratory does not guarantee the appropriate level in all the competencies corresponding to the subject (according to criteria 1, 4 and 5), it is considered that passing the programmed theoretical-practical tests is also an essential element of the evaluation, both in the ordinary and extraordinary calls, and in the two forms of evaluation foreseen: continuous and non-continuous.

Consequently, in order to pass the course, the student must demonstrate a minimum appropriate level of knowledge and skills in both test groups (theoretical and practical and experimental). Such minimum levels are set out in the qualification criteria (section 5.4).

The evaluation process is based on the continuous assessment of the student. However, students will have a period of fifteen days to request in writing to the Director of the Escuela Politécnica Superior their intention to use the final assessment model, giving the reasons they consider appropriate. The evaluation of the learning process of all students who do not apply for it or are denied it will be carried out, by default, according to the continuous evaluation model.

The following are the tests and evaluation procedures, as well as the qualification criteria corresponding to the ordinary and extraordinary calls.

A. Ordinary call:

A.1.Continuous evaluation:

a) To carry out the different evaluation tests that are established throughout the course.

b) To carry out the laboratory practices, of obligatory attendance.

c) Present and defend the results of one of the practices carried out.

d) To carry out a test of the theoretical set with several questions (analysis and/or synthesis) referring to concrete aspects of the subject matter covered by the theory classes.

e) To carry out a test of the problem-solving set referred to aspects covered in the theory sessions, exercises and laboratory.

A.2. Final evaluation. Students who opt for the final evaluation must pass a final test with the following contents:

a) A theoretical test that will cover in a broad way the contents of all the topics of the theory classes.

b) A problem test that will comprehensively cover the contents of all topics in the theory classes and exercises.

c) Practical laboratory test, which will cover the objectives programmed in the corresponding part of the course.

d) Presenting and defending the results of a part of the practical test carried out.

B.Extraordinary call:

B.1. *Continuous assessment:* For students who have participated in the continuous assessment process and have not passed it satisfactorily, the extraordinary call will consist of

a) A theoretical test that will cover in a broad way the contents of all the topics of the theory classes.

b) A problem test that will comprehensively cover the contents of all topics in the theory classes and exercises.

c) Practical laboratory test, which will cover the objectives programmed in the corresponding part of the course.

d) Presenting and defending the results of a part of the practical test carried out.

B.2. *Non-continuous evaluation:* The qualification procedure for this type of evaluation will be identical in both calls.

RATING INSTRUMENTS

This section summarises the marking instruments that will be applied to each of the assessment criteria. Assessment.

a. Writing, documentation and presentation of the results of a practical exercise (ET) carried out during the the laboratory sessions of the subject. With this instrument the following learning outcomes are graded learning outcomes: RA1, RA2, RA3.
b. Laboratory practicals (LAB). The practicals will complement the knowledge acquired in the theoretical part of the subject. This instrument is used to assess the learning outcomes: RA2, RA3
c. A final theoretical content test (PCT) with several questions (of analysis and/or synthesis) referring to specific aspects of the subject. (of analysis and/or synthesis) referring to specific aspects of all the contents and activities covered by the subject in the theory classes. subject in the theory classes. This instrument is used to assess the following learning outcomes learning outcomes:

RA1, RA2

d. A final problem set test (PCP) with several questions (of analysis and/or synthesis) referring to specific aspects of all the contents and activities covered by the subject in the theory classes (of analysis and/or synthesis) referring to specific aspects of all the contents and activities covered by the subject in the theory classes. the subject in the theory classes, exercises and laboratory. This instrument is used to assess the following learning outcomes learning outcomes: RA1, RA2.

GRADING CRITERIA

This section quantifies the evaluation criteria for passing the course.

A.Ordinary call

A.1. Continuous assessment: the relationship between the criteria, instruments and rating is as follows:

Competence	Learning Outcome	Assessment Outcome	Instrument Grading	Weight in the rating
CB6, CG1, CG2, CT2, CT5, CGestión1	RA1, RA2	CE1, CE2, CE4, CE5	PCT	25%
CB6, CB7, CT1, CT4, CT5, CG1, CG2, CG4, CG5, CTecTel14, CGestión1	RA1,RA2	CE1,CE2, CE4, CE5	PCP	25%
CG1,CG2, CG3, CG4,CG5, CG6, CB7, CB8, CB9, CB10, CT2, CT4, CT5	RA1, RA2, RA3	CE1,CE2, CE3, CE6	ET	10%
CG1, CG3, CG5, CT3, CT4,CT5, CTecTel14	RA2, RA3	CE2, CE6	LAB	40%

In order to be considered as having overcome the Continuous Assessment, students must satisfy the following conditions:

Successfully pass the evaluation of the competencies related to the laboratory practices of the subject. It will be understood that a student satisfactorily acquires these competences if he/she attends the laboratory and his/her qualification in the set of related tests (ET+LAB) is higher than 40 % of the maximum possible qualification.

To pass satisfactorily the evaluation of the competences related to the theoretical and problem part of the subject. It will be understood that a student satisfactorily acquires these competences if his qualification in the set of related tests (PCT+PCP) is equal or superior to 40 % of the maximum possible qualification.

In case of having passed the two previous parts, to obtain a global pondered grade equal or superior to 5/10.

In the case of not having passed any of the two parts, the student's final grade will be the lowest of the following:

4/10 points, if the result of the pondered sum is greater than that value.

Rating as "Not Presented"

The student within the continuous assessment process who does not participate in the assessment process will be marked as "Not Presented" in the ordinary call. It will be understood that the student has not participated in the continuous assessment process if any of the following circumstances apply:

They do not show up for any of the tests (PCT or PCP).

A.2.Final evaluation.

Whose criteria, instruments and raiting are the following

Competence	Learning Outcome	Assessment Outcome	Instrument Grading	Weight in the rating
CB6, CG1, CG2, CT2, CT5, CGestión1	RA 1, RA 2	CE1, CE2, CE4, CE5	PCT	40%
CB6, CB7, CT1, CT4, CT5, CG1, CG2, CG4, CG5, CTecTel14, CGestión1	RA1, RA2	CE1, CE2, CE4, CE5	PCP	40%
CG1,CG2, CG3, CG4,CG5, CG6, CB7, CB8, CB9, CB10, CT2, CT4, CT5	RA1, RA2, RA3	CE1, CE2, CE3, CE6	ET	10%
CG1, CG3, CG5, CT3, CT4, CT5, CTecTel14	RA2, RA3	CE2, CE6	LAB	10%

B.Extraordinary call

B.1. Continuous assessment:

For students who, having participated in the process of continuous assessment, have not passed it satisfactorily, the extraordinary call will consist of:

Competence	Learning Outcome	Assessment Outcome	Instrument Grading	Weight in the rating
CB6, CG1, CG2, CT2, CT5, CGestión1	RA 1, RA 2	CE1, CE2, CE4, CE5	PCT	40%
CB6, CB7, CT1, CT4, CT5, CG1, CG2, CG4, CG5, CTecTel14, CGestión1	RA1, RA2	CE1, CE2, CE4, CE5	PCP	40%
CG1,CG2, CG3, CG4,CG5, CG6, CB7, CB8, CB9, CB10, CT2, CT4, CT5	RA1, RA2, RA3	CE1, CE2, CE3, CE6	ET	10%
CG1, CG3, CG5, CT3, CT4, CT5, CTecTel14	RA2, RA3	CE2, CE6	LAB	10%

B.2.Final evaluation.

The rating criteria for this type of evaluation will be identical in both calls.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Documentation prepared by the teaching staff for the subject, which will be provided to the students directly, or with its publication on the subject's website.
- B.E.A. Saleh, M.C Teich, Fundamentals of photonics, Wiley Series in Applied Optics. John Wiley and Sons. Nueva York, 1991
- Kasap S.O, Optoelectronics and Photonics: Principles and Practices. 1ª Ed. Prentice Hall, 1999.
- Keiser G., Optical Fiber Communications 4th Ed., McGraw-Hill, Nueva York, 2008.
- Senior, J.M., Optical Fiber Communications: Principles and Practice 3rd Ed., Prentice Hall, 2009.
- H.J.R. Dutton, Understanding Optical Communications, IBM Redbooks, 1998.
- Páginas web sobre la temática de la asignatura que serán previamente seleccionadas por el profesorado.

6.2. Additional Bibliography

- J. Wilson, J.F.B. Hawkes, Optoelectronics: an introduction, Prentice-Hall, 1998.

· J. Capmany et al., Fundamentos de comunicaciones ópticas, Síntesis, 2001.

· J. Capmany et al., Dispositivos de comunicaciones ópticas, Síntesis, 2001.

· G.P. Agrawal, Fiber-optic communication systems, Wiley, 2002.

· A. Othonos, K. Kalli, Fiber Bragg Gratings. Fundamentals and Applications in Telecommunication and Sensing, Artech House, 1999.

· A. Rogers, Essentials of photonics 2nd Ed., CRC Press, 2009.

· Fiber Optics Handbook. Fiber, devices and systems for optical communications, M. Bass Ed, McGraw-Hill, 2002.

Disclosure Note

The University of Alcalá guarantees to its students that, if due to health requirements the competent authorities do not allow the total or partial attendance of the teaching activities, the teaching plans will achieve their objectives through a teaching-learning and evaluation methodology in online format, which will return to the face-to-face mode as soon as these impediments cease.