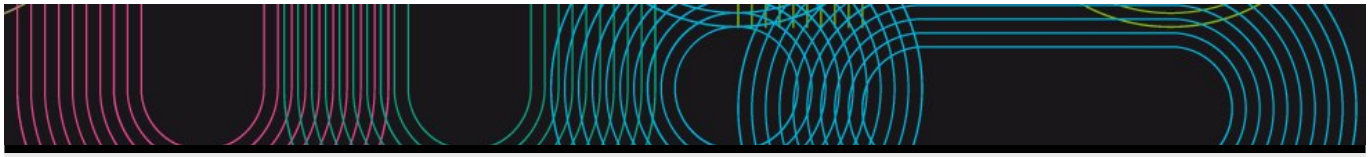

IDENTIFYING DATA				
Optical Communications				
Subject	Optical Communications			
Code	V05M145V01207			
Study programme	Telecommunication Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator	Curty Alonso, Marcos			
Lecturers	Curty Alonso, Marcos			
E-mail	mcurty@com.uvigo.es			
Web	http://faitic.uvigo.es			
General description	We review, in the first place, the physical foundations of optical fibre technology: propagation in fibre and both active and passive optical devices. Next, we analyse different advanced systems for fibre transmission and optical networks, and we discuss techniques to evaluate and design them.			

Competencies	
Code	
B1	CG1 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 The ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C13	CE13 The ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.

Learning outcomes	
Expected results from this subject	Training and Learning Results
1. Functional knowledge of the essential photonic devices for optical communications: LEDs and lasers, photodetectors, optical modulators, couplers, circulators, AWG, fibre amplifiers, semiconductor optical amplifiers, optical filters, single-mode fibres, multi-mode fibres and multicore fibres.	B4 C13
2. Knowledge of the noise models used to characterise the optical transmitter subsystems, optical amplifiers and receivers, and capacity to calculate its impact in terms of the signal to noise ratio and error probability.	B4 C13
3. Knowledge of the basic formats of digital transmission by optical fibre, and of analog transmission in systems fibre-radio.	B4 C13
4. Knowledge of some advanced systems for fibre transmission: new modulation formats, coherent systems, non-linear systems and dispersion management.	B4 B8 C13
5. Knowledge of the specific technologies of optical networks WDM and DWDM, and options to design them.	B1 B4 C13
6. Knowledge of the optical network topologies for long distance transmission, metropolitan and regional networks, and access optical networks.	B1 B4 C13
7. Knowledge of security techniques to protect optical networks.	B4 B8 C13

8. Knowledge of free-space optical systems and visible light communications.	B4 B8 C13

Contents	
Topic	
1. Introduction to optical communication systems	1.1. Reasons for optical transmission
2. Foundations of optical communications	2.1. Non-monochromatic propagation in linear optical fibres. 2.2. Basic active devices: lasers, LEDs, photodetectors, optical modulators and doped fibre amplifiers. 2.3. Basic passive devices: couplers, splitters and filters.
3. Advanced optical devices	3.1. Active devices: SOA, fibre lasers and Raman amplifiers. 3.2. Passive devices: AWG, gratings, circulators, plastic fibres and multicore fibres.
4. Non-linear effects in fibres and dispersion management	4.1. Stimulated Raman Scattering 4.2. Stimulated Brillouin Scattering 4.3. Dispersion management
5. Digital systems ETDM	5.1. Introduction 5.2. ETDM systems with optical amplifiers 5.3. Dispersion compensation in ETDM systems
6. Advanced optical systems	6.1. Systems fibre-radio. 6.2. Coherent links and new formats.
7. Optical networks	7.1. Systems WDM and DWDM 7.2. Switching technologies 7.3. Wavelength conversion. 7.4. Security in optical networks
Laboratory exercise 1. Dispersion in multi-mode fibres	Characterisation of both the intermodal and intramodal dispersion on a graded index fibre
Laboratory exercise 2. Optical modulator	Characterisation of an optical modulator
Laboratory exercise 3. Systems DWDM	Characterisation of DWDM systems working in third telecom window

Planning			
	Class hours	Hours outside the classroom	Total hours
Master Session	18	54	72
Laboratory practises	6	6	12
Case studies / analysis of situations	2	12	14
Long answer tests and development	2	12	14
Short answer tests	1	5	6
Case studies / analysis of situations	1	6	7
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Master Session	The professor introduces the main contents of each chapter to the students. Note, however, that these lectures do not cover all the contents of each subject. For that reason, the students have to review the supplementary notes provided in class. It is also expected that the students review the concepts introduced in the classroom and expand on their contents using the guide of each chapter, together with the recommended bibliography, as a reference. Through this methodology the competencies CG1, CG4, CG8 and CE13 are developed.

Laboratory practises	The lectures include some exercises in the lab involving different optical devices and optical communication systems. The students have to read the lab notes provided by the professor before the lab starts. At the beginning of each exercise the professor might request that the students summarise the main concepts related to the exercise. Any doubt can be solved using the office hours of the professor. Through this methodology the competencies CG4, CG8 and CE13 are developed.
Case studies / analysis of situations	It consists of activities that complement the master sessions and allow a better understanding of the theoretical concepts. Through this methodology the competencies CG1, CG4, CG8 and CE13 are developed.

Personalized attention

Methodologies	Description
Master Session	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.
Laboratory practises	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.
Case studies / analysis of situations	The students can use the office hours of the professor to solve doubts related to the subject. The timetable of these office hours will be available at the beginning of the semester and is published on the website of the course.

Assessment

	Description	Qualification	Training and Learning Results	
Long answer tests and development	At the end of the semester, the students will perform a final test that covers all the contents of the course.	30	B1 B4 B8	C13
Short answer tests	After the last lab session, the student will perform a test (20%) about the exercises done in the lab. Moreover, before the beginning of chapter 5, the students will perform a test (30%) about the contents of the first 4 chapters of the course.	50	B4 B8	C13
Case studies / analysis of situations	It evaluates the work realised by the student in the study of cases proposed in class.	20	B1 B4 B8	C13

Other comments on the Evaluation

We will offer to the students two possible assessment systems: continuous evaluation or final evaluation at the end of the course.

Each student has to decide on one of these two options by the third week of the course. In principle, the professor considers that the student decides continuous evaluation unless the student explicitly indicates by written statement to the professor that he decides final evaluation at the end of the course.

Continuous evaluation:

The continuous evaluation comprises a series of tasks that the student has to realise along the course (70%), together with a long answer test (30%) that he/she performs at the end of the course. These tasks include (a) the completion of one short answer test about the first four chapters of the subject (30%) and that it will take place the fourth week of the course, and the completion of one short answer test about the lab (20%) and that it will take place after the last lab exercise, and (b) the assessment of the activities realised by the student related with the 'case studies' (20%) that has to be completed by the seventh week of the course. The activities related to the 'case studies' could be performed in groups of students. In this case, the mark of the students in this task will be the mark of the group. All these tasks may not be retaken at another point in time. That is to say, if a student cannot fulfill them within the time stipulated by the professor, there is no possibility to do them afterwards. Also, they are only valid for the present academic year.

Those students who decide to opt for a continuous evaluation will have to fulfill the following conditions in order to pass the course: (a) perform at least 2 out of the 3 lab exercises; (b) obtain, at least, 8 points out of 20 in the 'case studies'; (c) obtain, at least, 12 points out of 30 in the long answer test; and (d) obtain a minimum of 50 points in total (i.e., taking all the activities into account). The final mark of those students who do not fulfill these minimum requirements will be calculated as

follows. It will be the minimum between: (i) the total number of points obtained by the student in all the activities of the course, and (ii) 40 points. That is to say, the maximum mark obtainable for these students is 40 points.

The choice of a continuous evaluation necessarily implies that the student is counted as present at the final evaluation, independently of whether or not the student has performed the long answer test.

Evaluation at the end of the semester:

In addition to the system of continuous evaluation described above, the student can opt for a final examination only. This final evaluation covers all the contents of the subject. The professor may demand the student to deliver some additional tasks, which will be notified by the fourth week of the course. These tasks have to be delivered on the day of the final examination. To pass the course the student will have to obtain, at least, 50 points out of 100 in the final exam together with the additional tasks.

Evaluation in July:

Those students who opted for a continuous evaluation and fulfill the requirements (a) and (b) above, will be able, if they so wish, to keep the mark obtained in the tasks performed during the continuous evaluation (70%). In such a case, they will only take a long answer test (30%). To pass the course, these students will have to obtain, at least, 12 points out of 30 in the long answer test, and obtain a minimum of 50 points in total.

Alternatively, these students can also opt for a final examination only, which covers all the contents of the course. In this case, the students will have to inform the professor one month prior to the final exam. Otherwise, it will be understood that the student opts for continuous evaluation.

The rest of students (i.e., those that opted for a system of continuous evaluation and do not fulfil the requirements (a) and (b) above, and those students that opted for a final exam only) will be evaluated by a final exam only, which covers all the contents of the course.

In the case of choosing a final exam only, the professor may demand the student to deliver some additional tasks, which will be notified to the student one month prior to the final exam. These tasks have to be delivered at the day of the final examination. To pass the course the student will have to obtain, at least, 50 points out of 100 in the final exam together with the additional tasks.

In case of detection of plagiarism in any of the works/tasks mentioned in the evaluations above, the final mark will be "fail (0)" and the professors will communicate this fact to the direction of the school such that it can take the measures that it considers appropriate.

Sources of information

There is no single book that covers all the contents of this subject. The bibliography below is only recommended. The class notes and the additional material given during the course constitutes the exact guide for this subject.

Additional bibliography:

1. J. Capmany, F. J. Fraile Peláez y J. Martí, Fundamentos de Comunicaciones Ópticas. Ed. Síntesis, Madrid (2001), 2nd Edition. (A list of errors and their corrections can be found in http://www.com.uvigo.es/~jfraile/erratas.pdf)
2. G. P. Agrawal, Fiber-Optic Communication Systems. Wiley-Interscience (2010), 4th Edition.
3. J. Capmany, F. J. Fraile Peláez y J. Martí, Dispositivos de Comunicaciones Ópticas. Ed. Síntesis, Madrid (1999).
4. G. Keiser, Optical Fiber Communications. McGraw-Hill (2014), 5th Edition.
5. J. Capmany y B. Ortega-Tamarit, Redes Ópticas, Ed. Universidad Politécnica de Valencia (2006).

Recommendations

Subjects that it is recommended to have taken before

Electronics and Photonics for Communications/V05M145V01202