Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Technologies and Telecommunications Systems

2. Date despre disciplină

2.1 Course name (ro) (en)				Comunicaţii optice Optical Communications			
2.2 Course Lecturer				S.l./Lect. Dr. Adrian Florin Paun			
2.3 Instructor for practical activities				S.l./Lect. Dr. Adrian Florin Paun			
2.4 Year of studies	4	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Op
2.8 Course type		S	2.9 Course code	04.S.08.A.224		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	14
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					50
Tutoring					0
Examinations					8
Other activities (if any):					0

3.7 Total hours of individual study	58.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Microwaves, Analog and Digital Communications, Data Communications, Information Theory and Transmission
4.2 Results of learning	General knowledge of the use of mathematical tools for the analysis of deterministic and random systems and signals. General notions about wave propagation in guided media and general notions about data communications (encoding, modulation, reception).

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The course takes place in a classroom equipped with a video projector. The classroom must also be equipped with a blackboard for demonstrations and interactive examples.
5.2 Seminary/ Laboratory/Project	The lab will take place in a specially equipped room, which must include: computers with Internet connection and installed software (Python, Matlab, Optisim).

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

This course aims to familiarize students with the main approaches, models, and explanatory theories in the field of fiber optic data transmission. The course provides students with the knowledge necessary to understand the architecture of an optical communication system, electro-optical and opto-electrical conversion operations, as well as the interaction between the optical carrier and the fiber.
The first part of the course briefly presents the theoretical concepts of the component blocks of an optical transmission system (optical emitter, modulator, optical fiber, receiver, optical amplifier) as well as the advantages and disadvantages of their main types of construction. Classic methods for compensating for the undesirable effects of fiber are also presented: attenuation, dispersion, and nonlinear effects. The last part of the course presents, as examples, long-distance optical transmission systems (WDN and DWDM) and fiber optic access networks (xPON).

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	This course aims to familiarize students with the main approaches, models and explanatory theories in the field of data transmission through optical fibers. The course provides students with the knowledge necessary to understand the architecture of an optical communication system, the electro-optical and opto-electrical conversion operations, as well as the interaction between the optical carrier and the fiber. In the first part of the course, the theoretical concepts of the component blocks of an optical transmission system (optical transmitter, modulator, optical fiber, receiver, optical amplifier) are briefly presented as well as. Demonstration of basic knowledge in the field of digital telecommunications, especially the requirements of a telecommunication system and performance criteria. General understanding of the structure of an optical fiber communication system, the function, parameters and limitations of the main components: optical transmitter, modulator, optical fiber, optical receiver, optical amplifier, coupler, splitter, circulator, mixer and optical polarizer.Exploring and understanding methods for analyzing the performance of individual components, as well as the optical transmission system. Developing a practical experience for demonstrating and evaluating the formation of topologies and the efficient use of resources, through simulation or experimental platforms. Arguing and analyzing coherently and correctly the context of application of basic knowledge of the field, using key concepts of the discipline and specific methodology. · Oral and written communication in Romanian and English: uses the scientific vocabulary specific to the field, in order to communicate effectively, in writing and orally.
Transversal (General) Competences	Students will be able to: - work in a team and communicate effectively, coordinating their efforts with others to solve problem situations of medium complexity. - have autonomy and critical thinking: the ability to think in scientific terms, to search for and analyze data independently, as well as to draw and present conclusions / identify solutions. - demonstrate the capacity for analysis and synthesis: to present the acquired knowledge synthetically, as a result of a systematic analysis process. - respect the principles of academic ethics: in the documentation activity, correctly cite the bibliographic sources used.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* Understanding the specific phenomena that occur in optical transmissions as a result of the interaction between the fiber and the optical carrier, as well as techniques to combat unwanted effects. Characterization of the components of an optical system: optical fiber, emitter, optical amplifier, receiver. Creating the skills necessary to evaluate the reception noise and ultimately the transmission performance, for different scenarios, using mathematical tools or simulators (e.g., Python, Matlab, Optisim).

Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* Select and group relevant information in a given context. Use specific principles in an argumentative manner to solve various problems with the help of a program. Can communicate, motivate and think creatively regarding specific problems and the principles underlying fiber optic transmission techniques Work productively in a team, being able to evaluate the performance of optical transmission schemes. Elaborate a scientific text. Experimentally verify identified solutions. Solve practical applications. Appropriately interpret causal relationships. Analyze and compare various ways of solving a problem Identify solutions and develop solution plans. Formulate conclusions to solved problems. Argue the identified solutions and ways of solving.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Select appropriate bibliographic sources and analyze them. Observe academic ethical principles, correctly citing the bibliographic sources used. Demonstrate receptivity to new learning contexts. Demonstrate collaboration with other colleagues and teaching staff in carrying out teaching activities.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Starting from the analysis of the students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on learning models by discovering the facilities for direct and indirect exploration of reality (experiment, demonstration, modeling), but also on action-based methods, such as exercise, practical activities and problem solving. Lectures will be used in the teaching activity, based on presentations that will be made available to students. The presentations use images and diagrams, so that the information presented is easy to understand and assimilate. This discipline covers information and practical activities intended to support students in their learning efforts and in developing optimal collaborative and communication relationships, in a climate favorable to learning through discovery. The ability to work in a team will be practiced to solve various learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction. Structure of an optical telecommunications system. Types, evolution and standardization of optical telecommunications systems	2
2	Optical fiber. Important fiber parameters. Effect of fiber on the propagation of optical pulses.	6

3	Optical emitters. Parameters and structures.	2
4	Optical receivers. Construction types and important parameters. Reception noise modeling and SNR evaluation	4
5	Optical transmission. Intensity modulation and direct detection (IM/DD). BER estimation and quantum limit	2
6	Optical amplifiers. Construction types and important parameters. Effect of optical amplifiers on digital transmission performance	4
7	Passive optical components: couplers, isolators, circulators, optical filters, attenuators, multiplexers and splitters.	2
8	Multiplexing techniques and optical transport technologies, DWDM systems. Attenuation and dispersion management in DWDM systems.	2
9	Multiple access techniques and optical access networks: (A)BPON, GPON, EPON, 10GPON	2
10	Advanced aspects - multilevel coherent modulations, nonlinear effects - modeling and performance	2
	Total:	28

Bibliography:

R. Hui, Introduction to Fiber-Optic Communications , Academic Press, 2019
G. Keiser, “Optical Fiber Communications”, McGrawHill, 2010.
John Senior, “Optical Fiber Communications: Principles and Practice (3rd Edition)“, Prentince Hall ,2009
Course notes - Moodle platform: https://archive.curs.upb.ro/2024/course/view.php?id=8956

LABORATORY

Crt. no.	Content	No. hours
1	Optical pulse propagation in optical fiber	2
2	Measuring a fiber optic link with OTDR	2
3	Modeling an IM/DD optical transmission system. Performance estimation	2
4	Optical amplifiers	2
5	Simulation of a DWDM transmission system with attenuation and dispersion management	2
6	The performance study of a coherent transmission with multilevel modulations	2
7	Final colloquium	2
	Total:	14

Bibliography:

Lab notes - Moodle platform: https://archive.curs.upb.ro/2024/course/view.php?id=8956

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	Knowledge of fundamental theoretical concepts	Verification test during the semester	20%
	Knowing how to apply theory to specific problems	Verification test during the semester	20%
	Differential analysis of theoretical techniques and methods	Verification test during the semester	20%
11.5 Seminary/laboratory/project	Appreciation in individual, independent solving of proposed problems within the framework of laboratory work	Worksheets	30%
	Appreciation of individual, independent solving of problems proposed within a homework assignment;	Problems	10%
11.6 Passing conditions			
Obtaining 50% of the total score.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

Through the activities carried out, students develop skills to provide solutions to problems and propose ideas to improve the existing situation in the field of optical communications.
In developing the content of the discipline, knowledge described in the specialized literature and in the own materials presented on the Moodle platform were taken into account.
The course has a similar content to courses conducted by other universities, such as the Technical University of Cluj, Gheorghe Asachi University of Iasi, and the Politehnica University of Timisoara.

Date	Course lecturer	Instructor(s) for practical activities
29.09.2025	S.l./Lect. Dr. Adrian Florin Paun	S.l./Lect. Dr. Adrian Florin Paun

Date of department approval	Head of department

Date of approval in the Faculty Council

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