Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

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	Masters
1.6 Programme of studies	Advanced Wireless Communications

2. Date despre disciplină

2.1 Course name (ro) (en)				Comunicații pe fibră optică Fiber Optic 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	2	2.5 Semester	I	2.6. Evaluation type	V	2.7 Course regime	F
2.8 Course type		DA	2.9 Course code	UPB.04.M3.O.21-24		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	1.50	3.3 seminary/laboratory	1.5
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	21	3.6 seminary/laboratory	21
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.					29
Tutoring					0
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	33.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Attending and/or passing the following lectures: Microwaves Analog and Digital Communications Data communications Physics
4.2 Results of learning	Accumulation of the following knowledge: - general knowledge about analog and digital signals, - fundamental knowledge of information transmission, - general notions regarding the propagation of electromagnetic waves - the ability to understand the operation of a block diagram or principle for communication systems in general - the ability to perform simulations using appropriate programming tools (Python) and to interpret the obtained results.

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

5.1 Course	The course will take place in a room equipped with video projector and computer
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a room with specific equipment, that must include PCs with programming tool Python. Compulsory lab activities (according to the internal regulations of National University of Science and Technology Politehnica Bucharest)

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 discipline is studied within the Master's program Advanced Wireless Communications and aims to provide students with advanced theoretical knowledge about optical fiber transmissions, nonlinear effects and their applications, electro-optical and opto-electrical conversions, modulations advanced digital optics, optical coupling and filtering, etc.
The course analyzes the main characteristics, components and functions of some optical communication systems for transport networks (DWDM, SONET, GMPLS), but also xPON optical access.
All of this contributes to conveying/training to/to students an overview of the methodological and procedural benchmarks related to the field.

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	Demonstrates basic/advanced knowledge of fiber optic communication systems. Correlates knowledge and applies theoretical knowledge in practice. Apply standardized methods and tools, specific to the field, to carry out the evaluation and diagnosis process of a situation, depending on the identified/reported problems, and identify solutions It argues and analyzes coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline and the specific methodology. Oral and written communication in a foreign language (English): demonstrates understanding of subject-related vocabulary in English.

Transversal (General) Competences	Works in a team and communicates effectively, coordinating efforts with others to solve problem situations of medium complexity. Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions. Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis. Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. Puts elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations

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.* List the most important phenomena and their effect on optical fiber transmissions. Defines notions specific to the field of optical communications. Identify the components and their functions in a fiber optic network. Describes/classifies notions/processes/phenomena that appear in optical communications. It highlights consequences and relationships.
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. Work productively in a team. Elaborate a scientific text. Solves practical applications and adequately interprets causal relationships. Formulate conclusions to the experiments carried out. Argue the identified solutions/workarounds.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Select appropriate bibliographic sources and analyze them. Respect the principles of academic ethics, correctly citing the bibliographic sources used. Demonstrates responsiveness to new learning contexts. Demonstrates collaboration with other colleagues and teaching staff in carrying out teaching activities Demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved Demonstrates social responsibility through active involvement in student social life/involvement in academic community events Promotes/contributes through new solutions related to the specialized field to improve the quality of social life. Realizes the value of its contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility). Apply principles of professional ethics/deontology in the analysis of the technological impact of the solutions proposed in the specialized field on the environment. Analyzes and capitalizes on business/entrepreneurial development opportunities in the specialty area. Demonstrates real-life situation management skills (collaborative vs. conflict time management).

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 students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct exploration and indirect of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.
In the teaching activity, lectures will be used, based on Power Point presentations or descriptive films of some phenomena, films that will be made available to the students.
Presentations use images and diagrams so that the information presented is easy to understand and assimilate.
This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introductory aspects: 1. The structure of an optical telecommunication system. 2. Types, evolution and standardization of optical telecommunication systems	2

2	Optical fiber, optical cables and connectors 1. Structure and constructive types of optical fiber 2. Attenuation in optical fiber (classifications, causes, effects) 3. Dispersion in optical fiber (classifications, causes, effects) 4. Linear and non-linear effects in optical fiber (classifications, effects) 5. Mathematical modeling of the interaction between the light and the optical fiber	4
3	Passive components used in optical networks: 1. Couplers, splitters. 2. Isolators, optical circulators 3. Optical filters and attenuators	2
4	Active optical components 1. Optical transmitters and modulators 2. Optical receivers 3. Optical amplifiers 4. Multiplexers and photonic switches	4
5	Digital modulations for optical transmissions 1. Modulations in intensity and direct detection. Schemes. Technical performances. 2. Modulations in intensity and coherent detection. Schemes. Technical performances. 3. Phase modulations and coherent detection. Schemes. Technical performances. 4. QAM modulations and coherent detection. Schemes. Technical performances. 5. Methods of compensation of linear and non-linear effects on the optical signal	4
6	Multiplexing techniques and optical transport technologies 1. DWDM systems 2. The SONET system 3. GMPLS networks	2
7	Multiple access techniques and optical access networks: 1. (A)BPON, network architecture and performance 2. GPON, network architecture and performance 3. EPON, network architecture and performance 4. 10GPON, network architecture and performance	2
8	Notions of control and management in optical networks	1
9	Trends in optical communication systems	0
	Total:	21

Bibliography:

G. Keiser, “Optical Fiber Communications”, McGrawHill, 2010.
W. B. Jones, “Introduction to Optical Fiber Communications Systems, HRW, 1988
John Senior, “Optical Fiber Communications: Principles and Practice (3rd Edition)“, Prentince Hall ,2009
Course notes in electronic form on the course website (Moodle)

LABORATORY

Crt. no.	Content	No. hours
1	Simulation of Gaussian-shaped optical pulse broadening due to dispersion.	2
2	Measuring and interpreting the results of measuring an optical fiber with OTDR	2

3	Study of optical receivers with direct detection vs coherent detection for intensity modulations	3
4	Modeling of optical amplifiers	2
5	Simulation of transmission on an optical link. Dispersion and attenuation management	4
6	Simplified simulation of optical transmission with wavelength division multiplexing (DWDM)	4
7	BER estimation for simple and complex optical modulations	4
	Total:	21
Bibliography: Laboratory notes in electronic form on the course website (Moodle)		

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	- knowledge of the concepts, principles of fiber optic communication and evaluation of its parameters and the performance of an optical transmission system with intensity modulation and direct detection.	One MCQ based exam, at the mid of the semester	20%
	- knowledge of the concepts, principles of a DWDM link and performance evaluation of a DWDM optical communication with attenuation and dispersion management.	One MCQ based exam, during the exam session	30%
	knowledge of the operating principles for optical communication technologies, their performances and applications.		
11.5 Seminary/laboratory/project	Performing the simulations, interpreting the results and solving the questions specified in the laboratory guide	Submitting the lab sheets with the results of the simulations and the answers to the questions	20%
	Simulation of a complex scenario of optical transmission with management of attenuation, dispersion and non-linear effects for performance evaluation. (Team study).	Presentation of the homework report in a session at the end of the semester	

11.6 Passing conditions
Obtaining 50% of the total score. Obtaining 50% of the score related to the activity during the semester.

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)

Internet access technologies (guided or wireless) and long-distance data transport at very low cost have enabled the development of the global communication system, being its essential components. The labor market is very interested in specialists in the development and maintenance of very high-speed optical transport and access networks, especially in the context of IoT implementation, when the demand for binary rates for data transmission will continue to grow.

The study of technologies in their evolution allows students to assimilate the necessary fundamental knowledge more easily.
The course curriculum responds to the current development and evolution requirements, subscribed to the European and world evolution in the field of communications and information technology (ICT). In the context of the current technological progress of electronic devices, the areas of activity targeted are those in the domain of very high speed telecommunications.

In this way, the graduates are provided with both appropriate competences with the needs of the current qualifications and a modern, high-quality and competitive scientific and technical training, which will allow them to be employed quickly after graduation.
This approach is perfectly in line with the policy of the National Polytechnic University of Science and Technology in Bucharest, both from the point of view of content and structure, as well as from the point of view of the skills and international openness offered to students.
Through the activities carried out within this discipline, students develop skills to offer solutions to some problems and to propose ideas for improving the existing situation in the field of technologies and optical access and transport networks. Also, the development of the graduate's skills to manage practical situations that he may face in real life is considered in order to increase his contribution to the improvement of the socio-economic environment.

Date	Course lecturer	Instructor(s) for practical activities
14.10.2024	S.l./Lect. Adrian Florin Paun PhD	S.l./Lect. Adrian Florin Paun PhD

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Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja
Date of approval in the Faculty Council	Dean
25.10.2024	Prof. Dr. Mihnea Udrea