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	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Microelectronics, Optoelectronics and Nanotechnologies

2. Date despre disciplină

2.1 Course name (ro) (en)				Sisteme optice de comunicaţii Optical Communication Systems			
2.2 Course Lecturer				Collaborator Dr. Florentin Vasile			
2.3 Instructor for practical activities				Asst./Lect. Dr. Alina-Elena Marcu, Collaborator Dr. Florentin Vasile			
2.4 Year of studies	4	2.5 Semester	2	2.6. Evaluation type	V	2.7 Course regime	Op
2.8 Course type		S	2.9 Course code	04.S.08.A.414		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3.5	Out of which: 3.2 course	2	3.3 seminary/laboratory	1.5
3.4 Total hours in the curricula	49	Out of which: 3.5 course	28	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.					26
Tutoring					0
Examinations					6
Other activities (if any):					0

3.7 Total hours of individual study	51.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Physics 1 & 2

4.2 Results of learning	General knowledge of optoelectronics, quantum mechanics, semiconductor physics, optical fibers, nonlinear effects, optoelectronic devices, optical amplifiers, optical solitons, optical networks, high-speed optical communication systems, multiplexing methods for optical communication systems, protocols used in communication systems, free-space optical communications, passive optical networks, optical systems and devices used to measure optical parameters in optical communication systems.

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 a video projector and a computer connected to the Internet.
5.2 Seminary/ Laboratory/Project	The laboratory will take place in the optoelectronics laboratory (room A402), with specific equipment. Attendance at the laboratory sessions is mandatory (according to the undergraduate study regulations at UNSTPB).

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)*

The general objective of the discipline is to familiarize students with different types of optical communication systems based on optical fibers, together with current development trends in this field. It also aims at acquiring knowledge for optical communication systems and their applications.

Course: the discipline studies the most important types of optical communication systems and presents their applications.

Laboratory: the laboratories focus on the most important optical communication systems and consist of studying and understanding the operation of optical communication systems together with their applications. Digital telephony. Introduction to SDH (Synchronous Digital Hierarchy). Introduction to OptiPerformer. Simulation of characteristics and parameters for various types of optical communication systems.

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 possession of basic knowledge in the field of optical communication systems. Coherently and correctly argues and analyzes the application context of the field's basic knowledge, using key concepts of the discipline and specific methodology. Oral and written communication in Romanian: uses the field-specific scientific vocabulary for effective written and oral communication.
Transversal (General) Competences	Works in a team and communicates effectively, coordinating efforts with others to solve medium-complexity problem situations. Autonomy and critical thinking: the ability to think in scientific terms, to independently search for and analyze data, as well as to draw and present conclusions / identify solutions. Capacity for analysis and synthesis: presents in a synthetic manner the knowledge acquired as a result of a systematic analysis process.

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.* Acquisition of fundamental concepts related to optical communication systems. Ability to correctly define notions specific to optical communication systems. Acquisition of particularities related to specific applications of optical communication systems.
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).* Application of basic knowledge, concepts, and methods regarding optical communication systems for their use in applications. Application of fundamental knowledge and concepts to optical communication systems. Ability to optimally use various optical communication systems in applications and projects. Solving specific design problems for optical communication systems. Ability to interpret experimentally obtained results and to formulate conclusions regarding them. Correct drafting of a laboratory report. Efficient performance of team activities.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Ability to select and consult bibliographic sources. Ability to learn new concepts. Ability to collaborate with other colleagues in carrying out didactic activities. Ability to communicate information to other colleagues. Development of autonomy within the learning process.

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.)*

Within the course, teaching activity is performed through direct instruction with paper/electronic course support and using a video projector (covering the communication and demonstrative functions). Images and diagrams are used so that the information presented is easy to understand and assimilate. The oral communication methods used are the expository method and problematization, used frontally. The didactic materials are the course notes and presentations, available on paper or in electronic format.

Regarding laboratory activity, the preferred teaching method is the expository one (covering the communication and demonstrative functions) and experimental laboratory applications. Students carry out the measurements specified in the assignment, and afterwards must prepare a report with the measurement results and their interpretations, accompanied by personal comments. The didactic materials are laboratory platforms available in printed format and electronic applications.

Teamwork skills will be practiced for solving different learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction History of telecommunications International system of units Basic acronyms used in optical telecommunications Parameters used in optical telecommunications Optical windows and optical bands in optical telecommunications	2
2	Optical guides and optical fibers Optical Fibers (OF): Multimode Single-mode Planar-symmetry optical waveguides - Structure of an optical fiber: symmetric structure antisymmetric structure multilayer structure Circular-symmetry optical waveguides - Optical fiber profile Step-index multimode optical fiber Graded-index multimode optical fiber Single-mode optical fiber OPGW (Optic Ground Wire) Multi-core optical fibers Plastic optical fibers Properties of OF Classification of OF according to ITU-T G.650-G.655 Recommendations Classification of OF according to materials used Transoceanic cables	2
3	Protocols used in communication systems PDH (Plesiochronous Digital Hierarchy) SDH (Synchronous Digital Hierarchy)/SONET (Synchronous Optical Network) ATM (Asynchronous Transfer Mode) IP (Internet Protocol)	2
4	Multiplexing methods for optical communication systems TDM and FDM. Evolution from WDM to DWDM WDM (Wavelength Division Multiplexing) CWDM (Coarse Wavelength Division Multiplexing) DWDM (Dense Wavelength Division Multiplexing) DWDM system, Basic components for DWDM ETDM (Electronic Time Domain Multiplexing) and OTDM (Optical Time Division Multiplexing) SDM (Space Division Multiplexing), PDM (Polarization Division Multiplexing), OAM (Orbital Angular Momentum Multiplexing). Long-haul (LH) optical fiber networks	2

5	Optical amplifiers EDFA (Erbium-Doped Fiber Amplifier) Raman amplification and Brillouin amplification Semiconductor Optical Amplifiers (SOA) Optical Parametric Amplifiers Other types of optical amplifiers: PDFA (Praseodymium-Doped Fiber Amplifier) NDFA (Neodymium-Doped Fluoride Fiber Amplifier) YDFA (Ytterbium-Doped Fiber Amplifier) TDFA (Thulium-Doped Fiber Amplifier) T-DFA (Tellurite-Doped Fiber Amplifier) Pumping schemes and applications	2
6	Nonlinear effects in OF: Maxwell's equations Propagation equation: Propagation of the nonlinear pulse Higher-order nonlinear effects Classification of nonlinear effects in OF: GVD (Group Velocity Dispersion) Different propagation regimes SPM (Self-Phase Modulation) 1. SPM induces spectral broadening 1.1 Nonlinear phase change 1.2 Changes in the pulse spectrum XPM (Cross-Phase Modulation) 1. XPM induces nonlinear coupling 1.1 Coupling between waves of different frequencies 1.2 Coupling between orthogonally polarized components 1.3 Nonlinear birefringence SRS (Stimulated Raman Scattering) 1. Basic concepts 1.1 Raman gain spectrum 1.2 Raman threshold SBS (Stimulated Brillouin Scattering) 1. Brillouin gain 2. Theory 2.1 Brillouin threshold 2.2 Pump depletion and gain saturation FWM (Four-Wave Mixing) Parametric processes	2
7	Optical Solitons Spatial soliton Temporal soliton Bright soliton Dark soliton Fundamental soliton and higher-order solitons (second-order soliton, third-order soliton, higher-order soliton)	2

8	Free-Space Optical Communication (FSO) FSO systems Applications for FSO	2
9	Optical networks Long-haul optical fiber networks Extended long-haul (ELH) Ultra long-haul (ULH) Wide Area Network (WAN) Metropolitan Area Networks (MAN) Access networks Local Area Networks (LAN) Network topologies Wide Area Network (WAN) SAN (Storage Area Networks) Optical Access Network (OAN)	2
10	High-speed optical communication systems. Optical channels of 100/200/400 Gbit/s. Trends.	2
11	Passive Optical Networks - PON Active Optical Networks - AON Components and characteristics Topology FTTx architecture types (FTTC, FTTH, FTTB, FTTN, etc.) Applications International standards for BPON, EPON, GEPON, and GPON Evolution	2
12	Optical systems and devices used to measure optical parameters in optical communication systems Power meter, Spectrum analyzer, OTDR (Optical Time-Domain Reflectometer), Optical network management and monitoring systems, etc.	2
13	Recap for optical communication systems Conclusions for optical communication systems	2
14	Final laboratory colloquium	2
	Total:	28

Bibliography:

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F. Vasile, C. M. Tebeica, P. Schiopu and M. Vladescu, “3D simulation for solitons used in optical fibers”, The 8th Edition of the International Conference Advanced Topics in Optoelectronics, Microelectronics and Nanotechnologies (ATOM-N 2016), Proc. SPIE Advanced Topics in Optoelectronics, Microelectronics, and Nanotechnologies VIII, pp. 20-25, December 2016.
F. Vasile and P. Şchiopu, “A simple method for determination of the optimum fiber length for EDFA”, International Conference Communications 2002, Proceedings of IEEE, pp. 142-147, December 2002.
F. Vasile and P. Şchiopu, “The wavelength dependence of the dispersion in single-mode fibers”, The 33-rd International Scientific Symposium of the Military Equipment and Technologies Research Agency (METRA 2002), Proceedings of METRA, vol. 3, pp. 11-17, May 2002.
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LABORATORY

Crt. no.	Content	No. hours
1	Digital telephony	4.5
2	Introduction to SDH (Synchronous Digital Hierarchy) - Part I	4.5
3	Introduction to SDH (Synchronous Digital Hierarchy) - Part II	4.5
4	Introduction to OptiPerformer. Simulation of characteristics and parameters for various types of optical communication systems.	4.5
5	Final laboratory colloquium	3
	Total:	21

Bibliography:
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F. Vasile şi A. Crăciun, ”Introducere în OptiPerformer. Simulare caracteristici şi parametrii pentru diverse tipuri de sisteme optice de comunicaţii, Material Laborator pentru Disciplina Sisteme optice de comunicaţii, 2020.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Exam	Multiple-choice evaluation test at mid-semester	30%
	Exam	Multiple-choice evaluation test at the end of the semester, in week 14 Note: The evaluation tests cover the entire material, including theoretical questions for assessing the knowledge accumulated.	20%
11.5 Seminary/laboratory/project	Knowledge of the characteristics and performance of the optical communication systems studied	Final laboratory colloquium, evaluated based on a test containing questions (both theoretical and applied) from the laboratory work carried out during the semester.	30%
	Course project	Course project evaluation	20%
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)

The science of measurement plays today, increasingly, a fundamental role in the development of modern industrial activities. More and more quantities have become measurable, which highlights measurement as an indispensable stage in the cognitive process and thus a defining factor in the progress of all sciences. Optical communication systems are tools that allow obtaining information about certain objects or phenomena.

Industry has a significant demand for qualified electronics engineers with competencies in the field of optical communication systems. The content of this course responds concretely to these current development and evolution needs, subscribed to the European service economy in the field of Electronic Engineering and Telecommunications (ETC). Thus, future graduates of the MON specialization are provided with appropriate competencies in optical communication systems, along with modern, high-quality, and competitive scientific and technical training that allows rapid employment after graduation and offers real professional openness, both at national and international levels.

Date	Course lecturer	Instructor(s) for practical activities
21.09.2026	Collaborator Dr. Eng. Florentin Vasile	Asst./Lect. Dr. Alina-Elena Marcu
		Collaborator Dr. Florentin Vasile

Date of department approval	Head of department
22.09.2026	Prof. Dr. Claudius Dan

Date of approval in the Faculty Council	Dean
22.09.2026	Prof. Dr. Mihnea Udrea