The syllabus of the discipline

Optical communication technologies

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Field name	Detailed content, comments
Name of the faculty	Faculty of Infocommunications
Level of higher education	First (bachelor's)
Code and name of the specialty	172 Telecommunications and radio engineering
Type and name of educational program	EPP "Information and Network Engineering"
Name of the discipline	Optical communication technologies
Number of ECTS credits	4,5
Discipline structure (distribution by types and hours of study)	28 hours - 14 lectures, 8 hours - 4 practical classes, 20 hours - 5 laboratory classes, 8 hours - 4 consultations, 71 hours - homework, **type of control**: exam
Schedule (terms) of studying the discipline	3rd year, VI semester
Prerequisites for studying the discipline	Basic knowledge of: 1. Guided electrical and optical communication systems 2. Technologies of transport networks 3. Technologies of TCRT means 4. Fundamentals of information and communication technologies
Competences, knowledge, skills, understanding, which is acquired by the applicant in higher education in the learning process	The discipline is used for formation the following competencies: - make and justify specific technical decisions in the development of fiber-optic communication systems based on modern TOZ; - to analyze technical problems, determine the purpose and perform the main tasks of designing fiber-optic systems and networks based on modern TOZ; - to calculate the basic parameters of optical systems and networks built on the basis of SDH, WDM and PON technologies.
The quality of the educational process	Educational-methodical and material-technical resource provision of the educational program, within the framework of which the discipline is studied, meets the licensing requirements and accreditation conditions of the educational activity of the university. Annual monitoring and revision of the curriculum of the discipline in accordance with the requirements and recommendations of the Ministry of Education and Science, state certification of acquired competencies of graduates, standards of cooperation with employers to ensure a competitive level of training. Adherence to the principles of academic integrity (https://lib.nure.ua/plagiat). Contains public information on the requirements, competencies, level of education within the current educational program

Description and content of the discipline

The purpose of studying the discipline is to master the basic principles and architectural features of the organization of modern optical communication technologies (TOS), their functional units and basic characteristics; mastering technical solutions for the use of these technologies in the design and construction of high-speed fiber-optic systems and communication networks for various purposes; study of methods of formation of optical linear path signals, reception and processing of optical signals in accordance with the TOZ under consideration; general methods for calculating the parameters of VOSZ based on technologies SDH, WDM, PON.

Content

Content module 1. Subject, purpose and objectives of the course. Basic concepts.

Topic 1. Introduction. Development, summary and general features of optical communication technologies. Time multiplexing method. The concept of digital hierarchy. The main features of the technology of plesiochronous digital hierarchy (PDH). The main features of synchronous digital hierarchy (SDH) technology. Wave channel multiplexing method. Technical characteristics, advantages and disadvantages of WDM systems.

Topic 2. Typical scheme and main components of fiber-optic communication system.

Typical scheme of VOS, transmitting (POM) and receiving (PROM) optoelectronic modules, their functional elements and functions, regenerator and its functions.

Topic 3. Features of stream multiplexing and formation of synchronous transport modules in SDH technology. SDH stream multiplexing scheme and its elements. Formation of synchronous transport module STM-1.

Topic 4. Directions of development, functional features and spectral ranges of WDM – technologies. Stages of development of WDM-systems, standard frequency plans of DWDM and their bands, the concept of fully optical network (AON).

Content module 2. Modern technologies DWDM, FTTX, xPON

Topic 5. Typical configuration of the DWDM network, the principles of its operation and the main functional units. Schematic of a typical configuration of the DWDM backbone network, its components and their purpose, types of optical amplifiers, DWDM signal amplification scheme of the optical communication line.

Topic 6. WDM wave multiplexing devices, technologies for their creation and the principle of operation. Channel multiplexing scheme, types of multiplexers, the principle of diffraction grating operation, multiplexer based on waveguide diffraction gratings, interference optical multiplexer scheme.

Topic 7. Optical insulators and calipers.Scheme of optical insulator: purpose, principle of operation and basic elements; schemes of optical circulators: purpose and principle of operation.

Topic 8. Optical amplifiers and their use in optical networks based on WDM family technologies. Physical features of OP functioning. Types of optical amplifiers and their features of use in WDM networks. The structure of the optical amplifier EDFA and features of its operation. Pump schemes OP EDFA. Varieties of EDFA amplifiers.

Technical parameters of OP EDFA.

Topic 9. Family of FTTX technology, features of their construction and operation.

FTTX technologies, principles of their construction, features of bringing the fiber to the "x" point, and FTTX-compatible transmission technologies.

Topic 10. Basic architecture, components, principle of operation and topological solutions for the organization of optical access networks based on PON technology.

Features of PON technology, basic architecture and main components of PON optical network, principles of downlink and uplink transmission, physical topologies of PON networks construction.

Topic 11. Standards for building PON networks. A-PON / B-PON standards and their features. E-PON / GEPON standards and their features The G-PON standard and its features.

Topic 12. General principles of building coherent POMs. The concept of "heterodyne" and "homodyne" detection. Block diagram of coherent VOMZ and its modes of operation.

Learning outcomes of higher education

As a result of studying the discipline, students must:

KNOW:

- basic technical features and architectural principles of organization of optical communication technologies;
- methods of formation of optical signals and formation of group optical streams, as well as methods of their regeneration and amplification in the process of transmission along the optical linear path for various optical communication technologies;
- purpose, technical characteristics and features of optical functional units used in TOZ;
- the main technical solutions used in the design of VOSP and construction of VOMZ on the basis of modern TOZ.

BE ABLE:

- make and justify specific technical decisions in the development of fiber-optic communication systems based on modern TOZ;
- to analyze technical problems, determine the purpose and perform the main tasks of designing fiber-optic systems and networks based on modern TOZ;
- to calculate the basic parameters of optical systems and networks built on the basis of SDH, WDM and PON technologies.

Assessment system according to each task for passing the test / exam

To assess the student's work during the semester, the final rating Qsem is calculated as the sum of grades for different types of classes and control measures. Each practical lesson is evaluated in 6 points (1 point for attendance and 5 points for work in the class). Each laboratory work is estimated at 6 points (1 point for attendance, 1 point for practice, 4 points for defense). 1 point is awarded for attending lectures. Classroom tests or tests - 19 points each (each). The maximum rating during the semester is 100 points.

The combined exam is used as a form of final control for the discipline. With this type of control, the final grade Pp is calculated by the formula:

$$Pp = 0.6 \times Q_{sem} + 0.4 \times Q_{isp},$$

where Q_{sem} - grade for the semester in a 100-point system,

Q_{isp} - grade for the exam in a 100-point system.

Type of lesson / control measure	Rating	
Lections		6 … 14
Lb № 1, 2, 3, 4, 5	(4 … 6)x5	20 … 30
Pr № 1, 2, 3, 4	(4…6)x4	12 … 24
Control point № 1		11…16
Control point № 2		11…16
Total for the semester		**60…100**

Qualitative evaluation criteria in the national scale and ECTS

Satisfactory, D, E (60-74). Show the required minimum of theoretical knowledge. Know the ways and methods of solving practical problems and be able to use them in practice.

Well, C (75-89). Firmly know a minimum of theoretical knowledge. Demonstrate the ability to solve a practical problem and justify all stages of the proposed solution.

Excellent, A, B (90-100). Show complete knowledge of basic and additional theoretical material. Unmistakably solve a practical problem, explain and justify the chosen method of solution. Criteria for assessing the knowledge and skills of the student in the combined exam.

Assessment scale: national and ECTS

The sum of points for all types of educational activities	ECTS assessment	Score on a national scale	
		for exam, course project (work), practice	for offset
90 – 100	**A**	perfectly	credited
82-89	**B**	fine	
74-81	**C**		
64-73	**D**	satisfactorily	
60-63	**E**		
35-59	**FX**	unsatisfactory with the possibility of reassembly	not credited with the possibility of re-assembly
0-34	**F**	unsatisfactory with mandatory re-examination	not credited with compulsory re-study of the discipline

Methodical support

Basic literature

1. Skliarov O.K. Volokonno-optycheskye sety y systemy sviazy. – M.: SOLON-Press, 2004. – 272 s.
2. Yvanov A.V. Volokonnaia optyka: komponenty, systemy peredachy, yzmerenyia. – M.: Kompanyia SAIRUS SYSTEMS, 1999. – 672 s.
3. V.B. Katok. Volokonno-optychni systemy zviazku. Kyiv: 1999 – 489 s.
4. Slepov N.N. Synkhronnыe tsyfrovye sety SDH. – M., 1998. - 152s.
5. Olyfer V.H., Olyfer N.A. Kompiuternye sety: pryntsypy, tekhnolohyy, protokoly – 3-e yzd., pererab. – SPb.: Pyter, 2003. – 864 s
6. Ubaidullaev P.P. Volokonno-optycheskye sety. – M.: Эko-Trenz, 1998. – 268 s.
7. Slepov N.N. Sovremennye tekhnolohyy tsyfrovykh optovolokonnykh setei sviazy. – M.: Radyo y sviaz, 2003. – 468 s.
8. Dyanov E.M., Kuznetsov A.A. Spektralnoe uplotnenye kanalov v volokonno-optycheskykh lynyiakh sviazy // Kvantovaia elektronyka. - 1983. - № 10. - S. 245–264.
9. Petrenko Y.Y., Ubaidullaev R.R. Passyvnye opycheskye sety PON. Chast 1. Arkhytektura y standarty // Lightwave RussianEdition 2004. - № 1. - S. 22–28.
10. Ubaidullaev R.R. Protiazhennye VOLS na osnove EDFA // Lightwave Russian Edition. - 2003. - № 1. - S. 22–28.
11. Xtera Communications Inc. Komponenty DWDM system y ykh kharakterystyky // LightWave Russian Edition. – 2005. – №2. – S. 50 - 56.
12. Velton-Telekom. Optycheskye usylytely v volokonno-optycheskykh lynyiakh sviazy. - Kh.: Velton-Tekhnokom, 2002. Otchet k kontraktu № 50/1 ot 2002-08-28.
13. Petrenko Y.Y., Ubaidullaev R.R. Passyvnye optycheskye sety PON. Chast 2. Ethernet na pervoi myle // LightWave Russian Edition. - 2004. - №2. – S. 25 – 32.
14. Petrenko Y.Y., Ubaidullaev R.R. Passyvnye optycheskye sety PON. Chast 3. Proektyrovanye optymalnykh setei // LightWave Russian Edition. - 2004. - №3. – S. 21 – 28.
15. Praktyka vnedrenyia passyvnykh optycheskykh setei [Elektronnyi resurs]. - Rezhym
16. Fotopryemnye ustroistva optycheskykh system peredachy [Elektronnyi resurs] / Volokonno-optycheskye systemy peredachy: Konspekt lektsyi. – Rezhym dostupa: www/URL: http://ndo.sibsutis.ru/magistr/courses_work/vosp_work/lec6.htm - 18.04.2008 h. - Zahl. s эkrana.
17. Klymash M.M., Lavriv O.A., Bak R.I. Optychni ta radiokanaly telekomunikatsii. – Lviv: 2010. – 424 s.

Supporting literature

1. Kovalchuk V.K. Volokonno-optycheskye systemy peredachy: Chast I. Elementy y uzly VOSP. / Ucheb. posobye. Kharkov, KhTURЭ, 1997. – 149 s.
2. Kovalchuk V.K. Volokonno-optychni systemy peredachi: Chastyna 2 / Navchalnyi posobnyk, KhNURE, 2000.
3. Alferov Zh.Y. Mnohokanalnaia dupleksnaia volokonno-optycheskaia lynyia sviazy na dlyne volny 1,3 mkm // Kvantovaia elektronyka. - 1982. - № 9, - S. 1698–1700.
4. Slepov N. N. Plezyokhronnaia y synkhronnaia tsyfrovye yerarkhyy // Sety. – 1995. - №9. – s. 90-101.

5. Sterlynh, Dzh. Volokonnaia optyka: per. s anhl. – M.: Lory, 1998. – 288 s.
6. Bakharevskyi A., Shokarev D. Reshenyia y produktы kompanyy Cisco Systems po postroenyiu optycheskykh setei. – Cisco Systems.– 2005. – 56 s.
7. Ahraval. Nelyneinaia volokonnaia optyka. – M.: Myr, 1996.
8. Lomashevych S.A. K probleme priamoho usylenyia kommutatsyy optycheskykh syhnalov. // Elektrosviaz, 1992 №11 s 14-16
9. Dyanov E.M., Prokhorov E.M., Deviatykh H.H. y dr. Volokonno-optycheskyi VKR-usylytel syhnalov na dlyne volnы 1,3 mkm. //Kvantovaia elektronyka, t.22 №9. -1995. S.810—814.
10. Spravochnyk po volokonno-optycheskym lynyiam sviazy. / L.M. Andrushko, V.A. Voznesenskyi, V.B. Katok y dr. / Pod red. S.V. Svechnykova y L.M. Andrushko. K.: Tekhnyka, 1988. – 259 s.
11. Sheremetev A.H. Koherentnaia volokonno-optycheskaia sviaz. – M.: Radyo y sviaz, 1991. – 192s.
12. Volokonno-optycheskye systemy peredachy y kabely: Spravochnyk / Pod red. Y. Y. Hrodneva. – M.: Radyo y sviaz, 1993.
13. Optycheskye systemy peredachy. Uchebnyk. / V. Y. Korneichuk, T. V. Makarov, Y.P. Panfylov. – K.: Tekhnika, 1994. – 388 s.

Methodical instructions for different classes

1. Metodychni vkazivky do samostiinoi roboty ta praktychnykh zaniat z dystsypliny «Optychni systemy zviazku» dlia studentiv usikh form navchannia napriamu 6.050903 - Telekomunikatsii / Uporiad. Yu.M. Koltun, N.A. Kharchenko S.A. Kapusta. – Kharkiv: KhNURE, 2011. – 60 s.;
2. Metodychni vkazivky do laboratornykh robit z dystsypliny «Tekhnolohii optychnoho zviazku» dlia studentiv usikh form navchannia napriamu 6.050903 - Telekomunikatsii / Uporiad. Yu.M. Koltun, N.A. Kharchenko S.A. Kapusta. – Kharkiv: KhNURE, 2013. – 40 s.*;
3. Metodychni vkazivky do praktychnykh zaniat i samostiinoi roboty z dystsypliny «Tekhnolohii optychnoho zviazku» dlia studentiv usikh form navchannia napriamu 6.050903 - Telekomunikatsii. / / Uporiad. Yu.M. Koltun, N.A. Kharchenko S.A. Kapusta. – Kharkiv: KhNURE, 2010. – 70 s.*;

Information support

1. Software package "Principles of SDH transport network construction". Developer Ukrtelecom Main Training Center.
2. Software package "SDH_PRJ". Developer Ukrtelecom Main Training Center.
3. Software package "PON Project" Developers Maxim Velichko, Rustam Ubaydulaev.