National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of Microelectronics

OPTOELECTRONIC INFORMATION SYSTEM

Syllabus

Details of the discipline	
Level of degree	***Master degree***
Branch of knowledge	17 Electronics, automation and electronic communications
Specialty	176 Micro- and nanosystem engineering
Educational program	OPP "Micro- and nanoelectronics"
Discipline status	preferable
Form of study	remote
Year and Semester of tuition	1-st year, spring semester
Amount of ECTS credits	4 ECTS credits
Semester control	exam
Розклад занять	
Language of teaching	English
Teacher	lectures: Koval Viktoriia, pvlab_kpi@ukr.net, 095 188 23 54 Seminars: Koval Viktoriia, pvlab_kpi@ukr.net, 095 188 23 54
Course placement	Class code: 3pius6i https://meet.google.com/xqx-bexc-wnn

Curriculum

1. Description of the discipline, its purpose, subject of study and learning outcomes

In the discipline "Optoelectronic information system" one can study of principle operation and ways of construction of optoelectronic systems for reception, transmission, transformation, display and storage of information. This course is interesting because it gives students the opportunity to get knowledge about modern optoelectronic technologies for receiving, transmitting, converting, displaying and storing information. Special attention is paid to the following topics: "Fiber-Optic Communication Systems", "Optoelectronic Computer Systems", "Image Recognition Systems", "Optoelectronic Storage Systems", "Optoelectronic Displays - LCD, OLED, AMOLED, PDP", "Holographic Displays" and "Video Projectors".

The purpose of the discipline is to form such students' abilities as:

– to give a physical substantiation of working mechanism of optoelectronic systems for reception, transfer, transformation, display and storage of the information;

– to compare the main parameters and characteristics of the different types of optoelectronic systems;

– to develop the structure of new types of optoelectronic information systems based on the studied approaches and considered examples.

This subject will provide the following student's ***competencies***: to improve modern and develop new types of optoelectronic information systems.

At the end of study the discipline, students must demonstrate the following learning outcomes:

knowledge: principle operation and ways of construction of optoelectronic systems for reception, transmission, transformation, display and storage of information.

skills*:* students should be able to evaluate the efficiency of existing optoelectronic information systems, to compare their in the term of the basic characteristics and to define the possible ways to improve their performance.

experience of the practical use of studied mechanisms of functioning, structure and basic parameters and characteristics of optoelectronic systems of reception, transmission, transformation, display and storage of information to evaluate the effectiveness of their work and ways to improve.

2. Prerequisites and Postrequisites of the discipline

To successfully study this discipline, students must master the following disciplines (***prerequisites***):

- ***Bachelor's courses:*** "Functional Electronics" / "Optoelectronics" / "Signal Theory" / "Physics Fundamentals of Sensors"
- ***Master's course:*** "Electronic sensors".

The learning outcomes of this discipline are used to study the following disciplines (***postrequisites***):

- ***Undergraduate practice and diploma design***
- ***PhD course:*** "Photonic and optoelectronic devices"

3. The content of the discipline

Title of sections and topics	Number of hours				
	Total	including			
		Lectures	Practical (seminar) classes	Laboratory / computer workshops	Independent work of student
1	2	3	4	5	6
Section 1. Mathematical bases of analysis of optoelectronic information conversion systems					
Topic 1. Evolution, classification and features of optoelectronic systems	2	2			
Topic 2. Elements of information theory	2	2			
Topic 3. Mathematical processing of optical signal	2	2			
Total within the Section 1	6	6			
Section 2. Optical communication systems					
Topic 1. Basic principles of construction for fiber-optic information transmission systems	13	2	2		9
Topic 2. Physics of information transmission by means of light in fiber optic cable	4	4			
Topic 3. Architecture of fiber-optic communication networks	2	2			
Test work 1	7	1			6
Total within the Section 2	26	9	2		15
Section 3. Optical computer systems					

1	2	3	4	5	6
Topic 1. Optical computer	6	4	2		
Topic 2. Optoelectronic image recognition systems	16	4	2		10
Total within the Section 3	22	8	4		10
Section 4. Optoelectronic information display systems					
Topic 1. 2D-systems for direct displaying of information	4	2	2		
Topic 2. 3D-systems for direct displaying of information	4	2	2		
Topic 3 Projection systems for displaying information.	9	2	2		5
Topic 4. Holographic systems for recording and displaying information	6	4	2		
Test work 2	7	1			6
Total within the Section 4	30	11	8		11
Section 5. Optoelectronic sensor systems					
Topic 1. Virtual reality systems	4	2	2		
Total within the Section 5	4	2	2		
Section 6. Optoelectronic systems for recording and storing information					
Topic 1. Laser systems for recording and storing information.	10				10
Topic 2. Holographic systems for recording and storing information.	12		2		10
Total within the Section 6	22		2		20
Review Paper	20				*20*
Exam	20				*20*
Total	150	36	18		96

4. Training materials and resources

1. Optical Communication Systems: Limits and Possibilities, edited by Andrew Ellis, Mariia Sorokina. – p.372. – 2020.
2. Tomoyoshi Shimobaba, Tomoyoshi Ito. Computer Holography: Acceleration Algorithms and Hardware Implementations. - CRC Press. – p.236. – 2019.
3. T. L. Singal. Optical Fiber Communications: Principles and Applications / 1st Edition. Cambridge University Press; p.468. – 2017.
4. Developing and Applying Optoelectronics in Machine Vision (Advances in Computational Intelligence and Robotics) edited by Oleg Sergiyenko, Julio C. Rodriguez-Quiñonez / 1st Edition/ IGI Global; p.341. – 2017.

Educational content

5. Methods of mastering for the discipline (educational component)

The method of mastering of the discipline is to study the theoretical part of the material in lectures and acquaint students with specific examples of optoelectronic information systems in seminars. In the lecture material the main emphasis is on the structure, mechanism of operation and basic parameters and characteristics of optoelectronic information systems. To improve visibility all lectures are accompanied by presentations, which are shown on the big screen with a projector.

The strategies of active and collective learning are applied, which are determined by the following methods and technologies:

1) research method of presentation (lectures);

2) personality-oriented (developing) technologies based on the method of "situation analysis", "discussion" and "express conference" (practical classes);

3) supplementing the traditional training sessions with means of interaction based on network communication capabilities (GoogleClassroom technology and electronic presentations for lectures).

Topics of lectures:

№	The title of the lecture topic and a list of key issues (with references to the literature)
1	Evolution, classification and features of optoelectronic systems: – The main stages of optoelectronic system development. – Features of transmission and processing of optical signals. – Classification and examples of modern optoelectronic systems.
2	Elements of information theory: – Basic principles of digital modulation and signal transmission – Optical signal and its information structure. – Two-dimensional Fourier transform.
3	Mathematical processing of optical signal: – Basic properties of two-dimensional Fourier transform. – Sampling of the optical signal. – Signal conversion by a linear system.
4	Basic principles of construction for fiber-optic information transmission systems: – Description of the structural scheme of fiber-optic communication networks. – Signal encoding and multiplexing in fiber-optic communication networks.
5-6	Physics of information transmission by means of light in fiber optic cable: – Types of optical fibers and their parameters. – Structure of fiber optic cable.
7	Architecture of fiber-optic communication networks: – Switching components in fiber-optic communication networks. – Network topology in fiber-optic communication networks.
8-9	Optical computer: – Advantages of the optical method of information processing. – Types of optical computing systems. – Analog optical processor. – Digital optical processor. – Hybrid optical processors.
10-11	Optoelectronic image recognition systems: – Basic concepts and classification of pattern recognition systems. – Optical text recognition systems.
12-13	Holographic systems for recording and displaying information: – Physical foundations of holography. – Types of holograms and areas of their use. – Materials and manufacturing technology of protective holograms.
14	2D-systems for direct displaying of information: – LCD display systems – OLED display systems

	– PDP display systems
15	3D-systems for direct displaying of information: – Stereoscopic 3D- display systems – Multiview 3D- display systems – Holographic 3D- display systems – Volumetric 3D- display systems
16	Projection systems for displaying information: – Projection means of displaying information – Ways to build a video wall.
17	Virtual reality systems: – Touch screens – Virtual reality means.
18	Test work 1 Test work 2

Topics of seminars:

№	Topics of seminars	Number of hours
1	Optoelectronic technologies in communication and telecommunication systems	2
2	Optoelectronic systems in computer technology	2
3	Optoelectronic systems in robotics and intelligent structures	2
4	Optoelectronic systems in science and medicine	2
5	Optoelectronic systems in industrial electronics	2
6	Optoelectronic systems in land transport and aviation	2
7	Optoelectronic systems in the military industry	2
8	Optoelectronic technologies in space systems	2
9	Optoelectronic technologies in security systems and in the fight against terrorism	2

6. Independent student work

№	The name of the topic that is submitted for independent study	Number of hours
1	Open channel optical communication systems	4
2	Soliton communication systems	5
3	Optical person identification systems	5
4	Neural network image recognition systems	5
5	LED and laser technology for building video walls/electronic boards	5
6	Laser systems for recording and storing information	10
7	Holographic systems for recording and storing information	10
8	Preparation of an individual review paper	20
9	Preparation for test work 1	6
10	Preparation for test work 2	6

11	Preparation for exam	20

Policy and control

7. Policy of academic discipline (educational component)

Lectures and seminars are held in the system GoogleClassroom (Class code: 3pius6i, https://meet.google.com/xqx-bexc-wnn). Attendance is not mandatory, but to pass the exam "automatically" you need to score more than 60 points, which can be gained by attending a lecture (passing an express test on the lecture material) and / or attending a seminar (by participating in the discussion).

Students are required to turn off audio and video during all classes, except for the speaker.

Points for ***work during the lecture*** are calculated on the basis of an express survey in the form of a test. Each test contains 3 questions to the material of the lecture, the correct answer to which will allow you to get 3 points.

The work at the seminar involves the asking questions to the speaker in the amount of not more than 1-2 on the topic of the report. For each question the student receives 1 point. As an incentive, additional points are provided to all students who prepare reports for the first seminar (5 points).

Control work is carried out in a lecture in the form of testing. Each test contains 10 questions, the correct answers to which allow you to get 10 points.

Independent work of student (Review Paper) – it is the implementation of an analytical review with the given structural scheme on the specified topic (the list of topics is given in section 5) and its defense in the form of a report at a seminar (with a presentation). Performed during hours of independent work. Points for the Review Paper are accrued on the basis of the completeness and the correctness of the Paper (maximum score - 12 points). Points for the defense of the Paper are calculated on the basis of the level of presentation and the correctness of the answers to the question on this topic (maximum score - 12 points).

Students who scored during the semester the number of points ≥ 60 have the opportunity not to take the exam. They get a grade "automatically" according to the rating obtained in the discipline. Students who did not score 60 points, or scored ≥ 60, but obtained grade is not satisfactory for them, take the exam without taking into account the semester rating points.

Conditions for admission to the exam - writing 2 control tests, preparation of the Review Paper and presentation on its base.

The exam is oral. The ticket for the exam consists of 2 questions on the topics, which are submitted for classroom classes, 1 section and separate questions, which are submitted for independent study.

8. Types of control and rating system for learning outcome assessing (RSA)

Current control: express survey (test) at the end of each lecture.

Intermediate control: twice a semester as a monitoring of the current state of compliance with the syllabus requirements (two control work in the form of tests).

Semester control: exam.

Conditions of admission to semester control: writing 2 control tests, preparation of the Review Paper and presentation on its base.

1. Rating system for assessing by types of classes:

№	Classes subject to rating assessment	Total number of tasks	Maximum score for 1 task	Maximum score for all tasks
1.	Lectures: -express survey (test)	16	3	48

2.	Seminars: -work in class	8	1	8
3.	Control works (tests)	2	10	20
4.	Individual Review Paper: - writing - defence (presentation and answer to questions)	1 1	12 12	12 12
Total semester points				100

2. Table of correspondence of rating points to grades on the university scale:

Number of points	*Score*
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactorily
64-60	Sufficiently
Less than 60	Unsatisfactorily
Admission conditions are not met	Not allowed

3. If, for objective reasons, the number of classes changes, the semester scores are adjusted accordingly.

9. Additional information on the discipline (educational component)

The list of questions for control work №1, on the basis of which test tasks are formed:

1. Signal conversion by a linear system.
2. Sampling of the optical signal.
3. Pulse-code modulation.
4. Two-dimensional Fourier transform and its properties.
5. Coding of signals in the fiber-optic information transmission system.
6. Types of optical fibers and their parameters.
7. Types of multiplexing. WDM technology.
8. Description of the block diagram of the fiber-optic communication system.
9. The structure of the fiber-optic cable.
10. Switching components of the fiber-optic communication system.
11. Networks topology of fiber-optic communication system.

The list of questions for control work №2, on the basis of which test tasks are formed:

1. Digital optical processor.
2. Hybrid optical processor.
3. Analog optical processor.
4. Basic concepts and classification of pattern recognition systems.
5. Optical text recognition systems.
6. Materials and manufacturing technology of protective holograms
7. Types of holograms and areas of their use
8. LCD display system
9. OLED display system
10. PDP display system
11. Stereoscopic 3D display systems

12. Multi-view 3D display systems
13. Holographic 3D display systems
14. Volumetric 3D display systems
15. Projection means of displaying information
16. Ways to build a video wall.

Syllabus was developed: Associate Professor, PhD, Koval Viktoriia

Syllabus was approved: Microelectronics Department (minutes № 22 date 23/06/2023)

Syllabus was agreed: Methodical commission of the Faculty of Electronics (minutes № 06/23 date 29/06/2023)