SYLLABUS OF THE COURSE

ELECTRONICS, MICROPROCESSOR TECHNOLOGY AND AUTOMATION TOOLS

Degree of education	First (bachelor)
Educational program	"Electrical energetics, electrical engineering and electromechanics"
Duration of teaching	3th-4th semester
Classes:	Autumn, Spring semester
Lectures (hours / weeks):	3(V term.), 2(VI, VII term), 2(VIII term)
laboratory classes (h / week):	2(V term), 3(VI, VII term), 2(VIII term)
Final control	Test
Language	English

Course page:: https://do.nmu.org.ua/course/view.php?id=3412
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1. Annotation

One of the features of the development of modern science and technology is the intensive development of electronics. Advances in electronics and integrated circuits are crucial for the development of computer-integrated technologies, artificial intelligence systems, microcontroller control devices and many other scientific and technical areas. The course is aimed at forming in students on the basis of a systematic approach to personal worldview, which allows you to freely navigate in theoretical and practical issues of structure, principles of operation, characteristics and applications of basic modern semiconductor devices used in electrical engineering and electromechanics. The study of the discipline lays the foundations of knowledge about the basic physical processes in semiconductors and the principles of structure and operation of basic electronic devices, analog and digital chips and integrated circuits, as well as practical skills in experimental study of characteristics and justification of choice and application of electronic devices. .

2. The purpose and objectives of the course

The purpose of the discipline is to form competences in the construction, principle of operation and analysis of processes in electronic circuits, microprocessor devices and sensors of automation systems, programming of microprocessor controllers.

Course objectives:

The study of the discipline should form knowledge of the purpose, principles of operation and parameters of electronic components and devices, architecture, structure and capabilities of microcontrollers and microprocessor systems, develop skills in the use of application software, microcontrollers and microprocessor technology to solve practical problems in professional activities.

3. Learning outcomes:

To understand the purpose, principle of operation and parameters of electronic elements, analog electronic devices, digital electronic devices, secondary power sources. To understand the architecture, structure, functionality of the basic microcontroller model, develop algorithms, compile and debug programs. Understand the principles of information display systems. Develop basic electrical schemes for connecting external devices and organize data exchange. Choose a controller and expansion modules to solve the task of automating a local industrial plant. Choose the type and model of the sensor, based on the task and conditions of detection, properties of the object and parameters of the environment, taking into account economic feasibility.

4. Course structure

LECTURES

1. **Element base of electronics.**
   1.1. Passive components of electronic circuits.
   1.2. Electrophysical properties of semiconductors.

1.3. Classification and general characteristics of semiconductor devices.
1.4. Diode group devices.
1.5. Bipolar and field-effect transistors.
1.6. Thyristors.
1.7. IGBT transistors.
1.8. Elements of optoelectronics.

2. **Analog electronic devices**
   2.1. Parameters and characteristics of analog devices.
   2.2. Electronic amplifiers of electrical signals.
   2.3. Operational amplifiers, analog circuits for operational amplifiers.
   2.4. Generators of sinusoidal oscillations.
3. **Digital electronic devices.**
   3.1. Fundamentals of logic algebra and digital integrated circuits of logic elements
   3.2. Sequential circuits: triggers, counters, registers.
   3.3. Combination devices: encoders, decoders, adders, multiplexers. comparison schemes
   3.4. Digital-to-analog and analog-to-digital converters (DAC and ADC).
4. **Secondary power sources.**
   4.1. Uncontrolled rectifiers. Parameters and characteristics.
   4.2. Schemes of single-phase and three-phase rectifiers.
   4.3. Smoothing filters
   4.4. Voltage and current stabilizers.

LABORATORY CLASSES

1. Study of structures, markings and images of radio components
2. Investigation of semiconductor diodes and zener diodes
3. Investigation of a bipolar transistor
4. Thyristor research
5. Calculation and study of low frequency amplifier on bipolar transistor
6. Calculation and study of the power amplifier
7. Research of amplifiers on the operational amplifier: inverting, non-inverting and subtracting
8. Research of the generator of sinusoidal oscillations on the operational amplifier
9. Research of passive forming devices
10. Research of relaxation generators on the operational amplifier
11. Research of the basic element of transistor-transistor logic
12. Research of trigger circuits
13. Research of meters and registers
14. Research of DAC and ADC
15. Investigation of uncontrolled rectifier with filters

Module 2

LECTURES

1. **Components of microprocessor devices. Number systems. General information about microprocessor systems. Implementation of arithmetic calculations and performance of logical calculations**

1.1. The purpose of the discipline. Methods of transmission, storage and processing of informatio.
1.2. Classification and purpose of microprocessor devices.
1.3. Number systems. Positional number systems.
1.4. Implementation of arithmetic and logical operations.

2. Single-chip microcontroller and single-chip microcontroller (OMC) command system of the MCS-51 family

2.1. MCS-51 microcontroller architecture. Memory organization and registers.
2.2. MCS-51 microcontroller instruction system.
2.3. Groups and types of instructions.
2.4. Integrated Development Environment (IDE).
2.5. Low and high level programming languages.

3. Basic program constructs. Bit processor

3.1. Classification of typical program constructs.
3.2. Program implementation of arithmetic data processing and logical operations.
3.3. Implementation of basic program constructs. Branching (condition), cycles.
3.4. Bit processor. Discrete data processing.
3.5. Debugging programs.

4. Internal peripherals microcontrollers of the MCS-51 family microcontrollers

4.1. Parallel ports of the microcontroller. Purpose, modes of operation.
4.2. Circuitry of parallel ports.
4.3. External devices connection diagrams.
4.4. Parallel, discrete and serial communication via ports.
4.5. Timers / counters. Purpose, modes of operation.
4.6. Organization of time intervals. Generating signals with specified time parameters.
4.7. Interrupt system. Purposes and modes.
4.8. Processing of external interrupts and interrupts from built-in devices.
4.9. Universal asynchronous receiver / transmitter (UART). Purpose, circuitry, modes of operation.
4.10. Sequential data exchange. Point-to-point and bus networks.

LABORATORY CLASSES

1. The architecture of the microcontroller 8051AH family MCS-51. Full-screen FD51 debugger-simulator.
2. MCS-51 family microcontroller instruction system. Typical program constructs.
3. Bit processor of the MCS-51 microcontroller. Programming in the integrated development environment IDE Keil uVision
4. Programming of arithmetic operations using microcontrollers of the MCS-51 family.
5. MCS-51 assembler. Training and adjusting stand EV8031 / AVR
6. Programming of data transmission in parallel format. Methods of displaying information.

Module 3
LECTURES

1. **Automation, its purpose. Classification of automated control systems and technical means of automation. Programmable logic controllers (PLCs). PLC programming languages**
   1.1. The purpose of automation of technological processes.
   1.2. Classification of automatic and automated systems. Local automation systems.
   1.3. Programmable logic controllers (PLCs). PLC programming languages.
2. **PLC Zelio Logic: overview, technical capabilities, hardware configurations. Ladder Diagram programming language**
   2.1. PLC Zelio Logic: appointment technical capabilities.
   2.2. Operating modes.
   2.3. Zelio Analog interfaces.
   2.4. Zelio Soft programming environment.
   2.5. Ladder Diagram (LD) programming language.
   2.6. Programming of typical tasks and logical functions
   2.7. Debugging programs.
3. **PLC Zelio Logic functions (internal program functional blocks)**
   3.1. Assignment of functions (internal function blocks).
   3.2. Main functions: timers, counters, comparators.
   3.3. Implementation of logic functions using ladder diagrams
   3.4. Debugging programs.
4. **Functional blocks programming using special functions (SFC)**
   4.1. Programming in the language of functional blocks (Functional Block Diagram, FBD)
   4.2. Basic functions: timers, counters, comparators, cam controller.
   4.3. Additional and service functional blocks.
   4.4. Logical elements.
   4.5. Grafcet special blocks (Special Functions, SFC).
   4.6. Macros.
   4.7. Supervisor window.
   4.8. Debugging programs.
5. **Sensors of automation systems**
   5.1. Purpose, classification, types of industrial sensors. Principles of action.
   5.2. Photoelectric sensors.
   5.3. Inductive sensors.
   5.4. Ultrasonic sensors.
   5.5. Capacitive sensors.
   5.6. Additional equipment.
   5.7. Circuitry and connection of sensors.
   5.8. Summary conclusions and recommendations for selection.

LABORATORY CLASSES

1. ZelioSoft 2 software shell: purpose, interface, methods of work..
2. Implementation of logical functions in the language of Ladder diagrams.

3. Internal functions of Zelio modules: purpose, modes, programming methods.
4. Programming of a typical cyclic mechanism control task (LD language).
5. Programming a typical cyclic mechanism control task (FBD language).
6. Programming a typical control task of a cyclic mechanism (Grafcet language).
7. Research of photoelectric sensors.
8. Research of inductive sensors.
9. Research of ultrasonic and capacitive sensors.

5. Hardware and / or software

Remote platform MOODLE, MS Teams

Multisim 11.0, FD51, Keil uVision, Zelio Soft 2 are used during laboratory works.

6. Evaluation system and requirements

6.1. The academic achievements of higher education students based on the results of the course will be evaluated on the scale below.

Rating scale	Institutional scale
90 – 100	Excellent
74-89	Good
60-73	Satisfactory
0-59	Fail

6.2. Laboratory works are accepted on control questions to each of work. Each work is evaluated on a 10-point scale.

6.3. The theoretical part is assessed by the results of passing at the end of each quarter of two control test tasks, each of which contains 25 questions. For the correct answer to one question the student receives 2 points (ie the maximum score for the theoretical part - 100 points).

6.4. Final grade for the course (on a 100-point scale):

$$FG = \frac{\frac{100}{150} S_{lr} \cdot 2 + S_{\text{т}} \cdot 2}{2 + 2},$$

where Slr – the sum of points for the delivery of laboratory work; $S_{\text{т}}$ – the sum of points for the theoretical part; 150 – the maximum amount of points for laboratory work; 100 - the maximum number of points for the theoretical part; 2 - the number of hours per week of laboratory work; 2 - the number of hours per week of lectures.

6.5. Applicants for higher education can receive a final grade in the discipline on the basis of current assessment of knowledge, provided that the number of points scored in the current testing of the theoretical part and laboratory work will be at least 60 points.

7. Course policy

7.1. Academic Integrity Policy

Academic integrity of higher education students is an important condition for mastering the results of training in the discipline and obtaining a satisfactory grade

from the current and final tests. Academic integrity is based on condemnation of the practices of copying (writing with external sources other than those allowed for use), plagiarism (reproduction of published texts by other authors without attribution), fabrication (fabrication of data or facts used in education). process). The policy on academic integrity is regulated by the Regulation "Regulations on the system of prevention and detection of plagiarism at the Dnipro University of Technology".http://www.nmu.org.ua/ua/content/activity/us_documents/System_of_prevention_and_detection_of_plagiarism.pdf.

In case of violation of academic integrity by the applicant (copying, plagiarism, fabrication), the work is evaluated unsatisfactorily and must be repeated. In this case, the teacher reserves the right to change the topic of the assignment.

7.2. Communication policy

Applicants for higher education must have activated university mail. All written questions to teachers regarding the course should be sent to the university e-mail.

7.3. Reassembly policy

Relocation takes place with the permission of the dean's office if there are good reasons (for example, sick leave).

7.4 Evaluation Appeal Policy

If the higher education student does not agree with the assessment of his knowledge, he may protest the assessment made by the teacher in the prescribed manner.

7.5. Attending classes.

For higher education students, full-time attendance is mandatory. Important reasons for non-attendance are illness, participation in university events, academic mobility, which must be confirmed by documents. The applicant for higher education must inform the teacher either in person or through the headmaster about the absence from classes and the reasons for absence.

For objective reasons (for example, international mobility) training can take place online in consultation with the course leader.

8 Recommended sources of information

Basic:

1. Основи електроніки : навч. посіб. / А. С. Васюра, Г. Д. Дорощенков, В. П. Кожем’яко, Г. Л. Лисенко. – Вінниця : ВНТУ, 2018. – 197 с.
2. Болюх В. Ф., Данько В. Г. Основи електроніки і мікропроцесорної техніки: Навч. посібник. – Харків: НТУ «ХПІ», 2011. – 257 с.
3. Гикавий В. А. Цифрова і аналогова схемотехніка / В. А. Гикавий. – Вінниця : ВДТУ, 2001. – 161 с..
4. Колонтаєвський Ю.П., Соколов А.Г. Електроніка і мікросхемотехника. Підручник (2-е вид.) / За ред. А.Г. Соскова. – К.: Каравелла, 2009. – 416 с.
5. Стахів П. Г. Основи електроніки: функціональні елементи та їх застосування: навч. посіб. / П. Г. Стахів., В. І. Коруд, О. С. – Л. : Вид-во Нац. ун-ту „Львівська політехніка”, 2002. – 120 с.
6. Колонтаєвський Ю. П. Конспект лекцій з дисципліни «Мікропроцесорна техніка» (для студентів, які навчаються за напрямом 6.050701 – Електротехніка та електротехнології всіх форм навчання) / Ю. П. Колонтаєвський;

Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова. – Харків : ХНУМГ ім. О. М. Бекетова, 2016. – 78 с.
7. Мікропроцесорна техніка [Текст]: навч. посібник/ В.В. Ткачов, Г. Грулер, М-59 Н. Нойбергер та ін. – Д.: Національний гірничий університет, 2012. – 188 с.
8. Технічні засоби автоматизації : навч.-метод. посібник / уклад.: А.К. Бабіченко, М. О. Подустов, І. Л. Красніков, О. Г. Шутинський, І. Г. Лисаченко, Ю. А. Бабіченко, О. М. Дзевочко, В. І. Вельма, О.В.Пугановський ; за ред. А. К. Бабіченка. – Х.: НТУ «ХПІ», 2021. – 217 с.
9. Яланський О. А. Комплект електронних презентацій з дисципліни «Засоби автоматизації».
10. Яланський О. А. Методичні вказівки до виконання лабораторних робіт №№ 1 – 4 «Модуль інтелектуального реле (програмований логічний контролер) Zelio Logic SR2 (3): призначення, функціонування, програмування, методи роботи», індивідуальних завдань та самостійної роботи з дисципліни «Автоматизація загально-промислових установок і технологічних комплексів» для студентів спеціальності 092203 «Електромеханічні системи автоматизації та електропривод» напряму «Електромеханіка»/ Упорядн.: О. А. Яланський – Дніпропетровськ: НГУ, 2011. – 76 с.
11. Яланський О. А. Методичні вказівки до виконання лабораторних робіт Z-5…Z-7 «Програмування у оболонці ZelioSoft 2 мовою діаграм функціональних блоків: інтерфейс, методи роботи» з дисципліни «Засоби автоматизації».
12. Яланський О. А. Методичні вказівки до виконання лабораторних робіт Д1.1…Д1.6, Д2.1…Д2.6 «Датчики систем автоматизації» з дисципліни «Засоби автоматизації».

Additional:

1. Титаренко М. В. Електротехніка та основи електроніки: Навчальний посібник для студентів інженерно-технічних спеціальностей вузів / М.В. Титаренко. – К.: Кондор, 2004. – 240 с.с
2. Бабак В. П. Обробка сигналів / В. П. Бабак, В. С. Хандецький, Е. Шрютер.
3. Комп'ютерна електроніка [Електронний ресурс] : підручник для студ. спеціальності 126 «Інформаційні системи та технології», спеціалізації «Інтегровані інформаційні системи» / А.О. Новацький ; КПІ ім. Ігоря Сікорського. – Електронні текстові дані (1 файл: 80.9 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2018. – 468 с.
4. Автоматизація виробничих процесів. Технічні засоби автоматизації: Навчально-методичний посібник до практичних робіт для здобувачів освітнього ступенів «бакалавр» галузі знань 15 «Автоматизація та приладобудування» та 18 «Виробництво та технології» усіх форм навчання [Електронний ресурс] / [Упоряд. В.В. Тичков, В.Я. Гальченко, Р.В. Трембовецька, К.В. Базіло]; М-во освіти и науки України, Черкас. держ. технол. ун-т. - Черкаси: ЧДТУ, 2020. - 321 с.

5. Мікропроцесорна техніка: Електронний підручник / В.Я.Жуйков, Т.О.Терещенко, Ю.С.Ямненко, А.В.Заграничний ; відп. ред. О.В. Борисов. 2016. – 440 с.
6. Мікропроцесорна техніка: Навчальний посібник з дисципліни для всіх форм навчання та студентів іноземців напряму підготовки 6.050701 “Електротехніка та електротехнології”/ Уклад. В.В.Кирик. – К.: ІВЦ «Видавництво «Політехніка», 2014. – 183с.
7. Городжа А. Д. Загальна Електротехніка та основи електроніки / А. Д. Городжа. – К.: КНУБА, 2000. – 150 с.
8. Електроніка і мікросхемотехніка: У 4-х т.т. /В.І.Сенько, М.В.Панасенко, Є.В.Сенько та ін. – К.: Обереги. – Т.1. Елементна база електронних пристроїв. – 2000. – 300 с.

Information resources:

1. Вікіпедія. Програмований логічний контролер:
https://uk.wikipedia.org/wiki/Програмований_логічний_контролер
2. Вікіпедія. Датчик:
https://uk.wikipedia.org/wiki/Датчик
3. Вікіпедія. Автоматизація виробництва:
https://uk.wikipedia.org/wiki/Автоматизація виробництва
4. Читальня ONLINE Науково-технічної бібліотеки ІФНТУНГ,
http://chitalnya.nung.edu.ua/elektronika-i-mikroshemotehnika.html-0
5. Література на сайті кафедри електропривода:
https://elprivod.nmu.org.ua/ua/books/electronics.php ,
https://elprivod.nmu.org.ua/ua/books/microcontrollers.php