Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Applied Radio Electronics

[RE-200] MULTIMEDIA TECHNOLOGIES IN RADIO COMMUNICATION

Curriculum of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	17 - Electronics, Automation, and Electronic Communications
Specialization	172 - Electronic Communications and Radio Engineering
Educational program	All educational programs
Discipline status	Elective (F-catalog)
Form of higher education	Full-time
Year of training, semester	Available for selection starting from the 4th year, spring semester
Scope of the discipline	4 credits (Lectures 18 hours, Practical classes 36 hours, Laboratory work 36 hours, Independent work 66 hours)
Semester control/control measures	Credit
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian Information
about course director / teachers	
Course location	

Course program

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

The academic discipline **"Multimedia Technologies in Radio Communications"** plays an important role in the training of future specialists in the specialty 172 - Electronic Communications and Radio Engineering. The educational component "Multimedia Technologies in Radio Communications" is an elective from the professional catalog and is studied in the eighth semester in accordance with the curriculum.

The aim of studying the academic discipline "Multimedia Technologies in Radio Communications" is to enable students to master the principles of effective use of modern technologies

multimedia in radio communications and familiarization with promising areas of their development.

The subject of study of this discipline is modern and promising multimedia technologies used in radio communications.

The objectives of the discipline are to familiarize students with the current state and trends in the development of multimedia hardware and software and to provide them with practical skills in the use of multimedia technologies in radio communications, namely: studying the features of the formation, compression, encoding, and decoding of multimedia audio and video signals, as well as their transmission via radio communication channels, studying the specifics of receiving, measuring parameters, and reproducing multimedia information from these signals.

In accordance with the requirements of the educational and professional program "Intelligent Technologies of Radio Electronic Equipment" (first) bachelor's level of higher education in the specialty 172 - Electronic Communications and Radio Engineering, students, after mastering the materials of the elective educational component "Multimedia Technologies in Radio Communications," must acquire the relevant general and professional competencies and achieve professional learning outcomes.

General competencies:

GC 1 Ability to think abstractly, analyze, and synthesize;

GC 2 Ability to apply knowledge in practical situations;

GC 4 Knowledge and understanding of the subject area and understanding of professional activities;

GC 7 Ability to learn and acquire modern knowledge;

GC 8 Ability to identify, set, and solve problems.

Professional competencies:

PC 1 Ability to understand the essence and significance of information in the development of a modern information society;

PC 2 Ability to solve standard tasks of professional activity based on information and bibliographic culture using information and communication technologies and taking into account the basic requirements of information security;

PC 3 Ability to use basic methods, means, and tools for obtaining, transmitting, processing, and storing information;

PC 4 Ability to perform computer modeling of devices, systems, and processes using universal application software packages;

PC 5 Ability to use regulatory and legal documentation related to information and telecommunications networks, telecommunications and radio engineering systems (laws of Ukraine, technical regulations, international and national standards, recommendations of the International Telecommunication Union, etc.) to solve professional tasks;

PC 13 Ability to organize and implement occupational health and safety measures in the process of operation, maintenance, and repair of information and telecommunications networks, telecommunications and radio engineering systems:

PC 14 Ability to study scientific and technical information, domestic and foreign experience on the subject of investment (or other) projects for the development of telecommunications and radio engineering equipment;

PC 20 Ability to select methods and means of information processing using intellectual technologies.

Program learning outcomes:

PLO 1 Analyze and make informed decisions when solving specialized tasks and practical problems in telecommunications and radio engineering, which are characterized by complexity and incomplete certainty of conditions;

PLO 2 Apply the results of personal search and analysis of information to solve qualitative and quantitative problems of a similar nature in information and communication networks, telecommunications and radio engineering systems;

PLO 3 Identify and apply in professional activities methods for testing information and telecommunications networks, telecommunications and radio engineering systems of intelligent technologies for compliance with the requirements of domestic and international regulatory documents;

PLO 6 Adapt to changes in information and communication networks, telecommunications and radio engineering systems technologies.

PLO 7 Competently apply terminology in the field of telecommunications and radio engineering;

PLO 8 Describe the principles and procedures used in telecommunications systems, information and telecommunications networks, and radio engineering;

PLO 25 Select and implement means and methods of information transmission in communication networks and apply network technologies;

PLO 27 Apply basic methods and techniques for obtaining information;

PLO 29 Select the configuration, structure, main components, nodes, and elements of radio- electronic equipment depending on its purpose.

Within the framework of the above-mentioned general and professional competencies and program learning outcomes, students should acquire basic **knowledge of**: modern multimedia technologies; the basic principles and features of the construction, deployment, and operation of wireless telecommunications networks that provide multimedia signal processing; the basic principles of the construction and operation of typical means of reproducing sounds and images of hardware and software multimedia complexes.

Be able to: develop educational multimedia products; use ready-made multimedia products in their activities; place their own multimedia resources on the Internet; use operations and procedures at the stage of forming technical specifications for the design of new wireless telecommunications networks intended for processing multimedia signals; measure and evaluate the parameters of multimedia technology signals when receiving them via radio lines; configure radio communication equipment for processing multimedia technology signals.

Be able to: use software tools for developing multimedia products; process text, graphics, video, sound, and animation; analyze the principles of organization, construction, and use of multimedia technologies in radio communications and implement them in practical activities.

2. Prerequisites and post-requisites of the discipline (place in the structural-logical scheme of training under the relevant educational program)

For successful mastery of the discipline, students must have knowledge obtained from studying the following disciplines in accordance with the structural-logical scheme of training under the educational program: "Computer Science. Part 1", "Computer Science. Part 2", "Fundamentals of Metrology",

"Higher Mathematics. Part 1," "Higher Mathematics. Part 2," "Higher Mathematics. Part 3," "General Physics. Part 1," "General Physics. Part 2," "Engineering and Computer Graphics. Part 1," "Engineering and Computer Graphics. Part 2," "Fundamentals of Circuit Theory. Part 1," "Fundamentals of Circuit Theory. Part 2," "Electrodynamics and Radio Wave Propagation,"
"Circuitry. Part 1," "Radio Electronics in Intelligent Systems," "Wireless Technologies for Intelligent Radio Electronics Equipment. Part 1," "Fundamentals of Telecommunications and

Radio Engineering Theory. Part 1," "Fundamentals of Telecommunications and Radio Engineering Theory. Part 2."

Mastering this academic discipline can be useful for students when completing their pre-diploma internship and diploma project.

3. Course content

Topic 1. Basic information about multimedia technologies. The essence of the concept of "multimedia." Classification of multimedia technologies. Areas of application of multimedia technologies in radio communications.

Topic 2. Hardware for working with multimedia information. Information input devices (multimedia audio system): Manipulators, scanners, digitizers, video cameras, web cameras, digital cameras, microphones, players, recorders, synthesizers, audio adapters and their processors. Information output devices: monitors, printers, speaker systems, touch screens. Information processing devices: sound cards, video cards, tuners. Interactive tables, boards, multimedia projectors.

Topic 3. Software for working with multimedia information

Software for developing multimedia products (multimedia applications). Stages and technology of creating multimedia products. Creating multimedia presentations. Multimedia products for publication on the Internet. Development of multimedia applications using authoring tools. Development of multimedia products using programming languages. Multimedia products for educational purposes. Legislation in the field of multimedia, copyright, protection, licensing. Text as a basic part of multimedia. Hypertext. Sharing media materials on the Internet. Web 2.0 technologies - the second generation of network services. Creation and sharing of media materials. Joint creation and editing of hypertexts. WikiWiki service. Embedding media objects in Wiki.

Topic 4. General information about sound processing in multimedia

Basic information about sound. Sound as a component of multimedia. Parameters of multimedia devices in acoustics: frequency response amplitude reduction level, nonlinear distortion coefficient, noise level, dynamic range. Digitization of analog signals. Digital audio signal processing and its advantages. Sound formats and sound files. Multi-channel sound systems. General information about compression. Uncompressed and lossless formats: WAV, AIFF, CD-DA, SACD, and DVD-audio. Lossless compression formats: FLAC, ALAC, WavPack, APE, TTA, SHN, OptimFROG. Lossy compression formats: MPEG family, Ogg Vorbis, MusePack, WMA, PAC, QDesign AIF, LossyWAV, Opus.

Topic 5. Software and hardware tools for sound processing in multimedia

Dynamic processing of audio signals. Frequency processing of audio signals: smooth rise and fall filters, cutoff filters, presence filters, equalizers. Spatial processing devices. Methods and devices for creating special sound effects: delay (Delay/Echo), chorus (Chorus), flanger (Flanger), phaser (Phaser) and wah- wah (Wah-Wah), vocal stressor, vibrato generators, exciter (Exciter), enhancer, sonic maximizer, vitalizer, pitch shifters, tempo shifters.

Topic 6. Graphics in multimedia

Computer graphics and its place in the multimedia system. Raster graphics: general principles of working with raster graphics, color models, raster graphics formats. Vector graphics: general principles of working with vector graphics, vector graphics formats. Fractal graphics. Three-dimensional graphics. Animation and visualization. General information about information compression. Lossless compression: RLE compression, Huffman and CCITT encoding, LZW encoding, deflation method, JBIG method. Efficiency of lossless compression methods. Lossy compression: JPEG method, wavelet compression, fractal compression. Characteristics of BMP, TIF, GIF, JPG, and other formats.

Topic 7. Video information and its processing in multimedia systems

Video information as part of multimedia. Television systems. Video signal formats. Digital television signal transmission. Video compression. General information. Video image compression and decompression standards. Media containers and video codecs. Creating and editing video files.

Topic 8. Multimedia and the Internet

Transmission of video information streams over an information and communication network. YouTube video feeds. Creating a YouTube channel and YouTube broadcasting. Multimedia presentations

Topic 9. NGN networks. SMS equipment.

Architecture of the IMS multimedia communication subsystem and its properties. IMS functional capabilities. IMS standardization. User and service identification. IMS architecture. IMS network access technologies. User registration procedure in the IMS network. IMS session establishment procedures.

4. Teaching materials and resources

Basic literature:

1. *Multimedia technologies and teaching aids: textbook / A. M. Gurzhii, R. S. Gurevich, L. L. Konoshevskii, O. L. Konoshevskii; edited by Academician of the National Academy of Pedagogical Sciences of Ukraine Gurzhii A. M. –*
Vinnytsia: Nilan-LTD, 2017. – 556 p.

Additional literature:

1. *Furht, Borko. Encyclopedia of Multimedia / Borko Furht. – Springer, 2008. – 983 p.*

2. *Zhuk, Yu. A. Multimedia Technologies [Electronic resource]: textbook: independent study electronic edition / Yu. A. Zhuk; Syktyvkar Forestry Institute. – Electronic data. – Syktyvkar: SLI, 2012. – Access mode: http://lib.sfi. komi.com. – Title from the screen.*

Educational content

5. Methodology for mastering the academic discipline (educational component)

No No	Lecture topic and list of educational questions	Number hours
1	Lecture No. 1 Concepts, classification, and areas of application of multimedia technologies 1. The essence of the concept of "multimedia." 2. The four essences of multimedia 3. Classification of multimedia technologies 4. Areas of application of multimedia technologies in radio communications	
2	Lecture No. 2 Hardware for working with multimedia information Input devices (multimedia audio system): Manipulators, scanners, digitizers, video cameras, webcams, digital cameras, microphones, players, recorders, synthesizers, audio adapters, and their processors 2. Information output devices: monitor, printer, speaker systems, touch screens 3. Information processing devices: sound cards, video cards, tuners 4. Interactive tables, boards, multimedia projectors.	

3	Lecture No. 3. Software tools for creating and editing multimedia elements and multimedia applications Software for developing multimedia products (multimedia applications) 2. Stages and technology of creating multimedia products. 3. Creating multimedia presentations 4. Multimedia products for publication on the Internet 5. Development of multimedia applications using authoring tools 6. Development of a multimedia product using a programming language 7. Multimedia products for educational purposes. Legislation in the field of multimedia, copyright, protection, licensing.	
4	Lecture No. 4 Working with sound 1. Basic information about sound. 2. Sound as a component of multimedia Parameters of multimedia devices in acoustics: frequency response amplitude reduction level, nonlinear distortion coefficient, noise level, dynamic range. Digitization of analog signals. Digital audio signal processing and its advantages. 5. Sound formats and sound files. 6. Multichannel sound systems	
5	Lecture No. 5 Compression of sound information 1. General information about compression. 2. Uncompressed and lossless formats: *WAV, AIFF, CD-DA, SACD, and DVD-audio* Lossless compressed formats: *FLAC, ALAC, WavPack, APE, TTA, SHN, OptimFROG* Lossy compressed formats: *MPEG* family*, Ogg Vorbis, MusePack, WMA, PAC, QDesign AIF, LossyWAV, Opus*	
6	Lecture #6. Software and hardware tools for sound processing 1. Dynamic processing of audio signals Frequency processing of audio signals: smooth rise and fall filters, cutoff filters, presence filters, equalizers 3. Spatial processing devices Methods and devices for creating special sound effects: delay (*Delay/Echo*), chorus (*Chorus*), flanger (*Flanger*), phaser (*Phaser*), and wah-wah (*Wah-Wah*), vocal stressor, vibrato generators, exciter (Exciter), *enhancer*, *sonic maximizer*, *vitalizer*, devices pitch change devices, sound duration change devices	
7	Lecture No. 7. Raster and vector graphics 1. Computer graphics and its place in the multimedia system Raster graphics: general principles of working with raster graphics, color models, raster graphics formats Vector graphics: general principles of working with vector graphics, vector graphics formats 4. Fractal graphics 5. Three-dimensional graphics 6. Animation and visualization. 7. Multimedia presentations	
8	Lecture No. 8. Compression of graphic information 1. General information about information compression Lossless compression: RLE compression, Huffman and CCITT coding, LZW coding, deflation method, JBIG method. Effectiveness of lossless compression methods 3. Lossy compression: JPEG method, wavelet compression, fractal compression 4. Characteristics of BMP, TIF, GIF, JPG, and other formats.	
9	Lecture No. 9. Working with video in multimedia 1. Video as part of multimedia 2. Television systems. Video signal formats 3. Digital representation of television signals	

10	Lecture No. 10 Processing video information in multimedia systems 1. Compression of video information. General information 2. Video image compression-decompression standards. 3. Media containers and video codecs 4. Creating and editing video files.	
11	Lecture No. 11 Real-time transmission of multimedia information over the Internet. *VoIP* technology. 1. Video transmission over the network 2. *YouTube* videos. Creating a YouTube channel and YouTube broadcasting. 3. Video conferencing: general information, types of video conferences 4. Types of video conferencing system architectures	
12	Lecture No. 12 NGN networks. IMS equipment. 1. Architecture of the IMS multimedia communication subsystem and its properties. 2. IMS functional capabilities. 3. IMS standardization. 4. User and service identification. IMS architecture. IMS network access technologies. User registration procedure users in the IMS network. Procedures for establishing a session in IMS.	

Practical classes (seminars)

The main objectives of the practical training cycle are to reinforce the theoretical material studied in lectures and during independent work

No. No	Practical class topic	Number hours
1	Practical lesson No. 1. Technology for creating a slide film	
2	Practical lesson No. 2. Editing and recording sound	
3	Practical lesson #3. Editing and processing images	
4	Practical lesson #4. Editing and processing video content	
5	Practical lesson No. 5. Software and hardware for creating, transmission, and analysis of multimedia transport streams	

Seminar classes

No seminars are planned for this course.

Laboratory work

Laboratory work for the course "Multimedia Technologies in Radio Communications" is carried out with the aim of deepening theoretical knowledge of the subject and acquiring practical skills for applying the knowledge gained to solve applied problems in the specialty 172 - Electronic Communications and Radio Engineering.

No No	Title Title of laboratory work	Number hours
1	Laboratory work No. 1. Creating a multimedia video presentation	
2	Laboratory work No. 2. Processing a video presentation using the *Movavi Video Suite* software package and researching multimedia video and audio encoding formats using the AnyMP4 Video Converter software package. *AnyMP4 Video Converter*	
3	Laboratory work No. 3. Researching the structure and parameters of a multimedia multichannel speech television stream using using the *TSReader* and *MPEG-2 TS Analyzer* software packages	
4	Laboratory work No. 4. Investigation of the principles of formation multimedia television digital transport stream	
5	Laboratory work No. 5. Research into OTT and IPTV technologies for multimedia broadcasting of television programs	
6	Laboratory work No. 6. Formation of multimedia streams of speech using Dektec DTA-107 and DTA-115 modulators	

7	Laboratory work No. 7. Using the *GNURadio* software environment to generate and transmit multimedia streams of speech television using the *BladeRF x40 SDR* transceiver	
8	Laboratory work No. 8. Organizing the broadcast of multimedia streams in a local computer network	
9	Laboratory work No. 9. Creating audio and video podcasts using *Cast Box and Sound Cloud* cloud environments. Organizing online broadcasts on *YouTube*	

6. Independent work by students

Independent work assignments for students are specified in the methodological guidelines for each lecture and practical class.

No. No	Title of topics and questions for independent study	Number hours
1	Lecture No. 1 Concepts, classification, and areas of application of multimedia technologies	
2	Lecture No. 2 Hardware for working with multimedia information	
3	Lecture No. 3. Software for creating and editing multimedia elements and multimedia applications	
4	Lecture No. 4 Working with sound	
5	Lecture No. 5 Compression of sound information	
6	Lecture No. 6. Software and hardware tools for sound processing	
7	Lecture No. 7. Raster and vector graphics	
8	Lecture No. 8. Compression of graphic information	
9	Lecture No. 9. Working with video in multimedia	
10	Lecture No. 10 Processing video information in multimedia systems	
11	Lecture No. 11 Transmission of multimedia information in real time via the Internet. *VoIP* technology.	
12	Lecture No. 12 NGN networks. IMS equipment.	

Policy and control

7. Policy of the academic discipline (educational component)

The educational component "Multimedia Technologies in Radio Communications" is studied in the eighth semester in lectures, practical and laboratory classes. The quality of students' mastery of the discipline is monitored through regular ongoing assessment in lectures, practical and laboratory classes, as well as through a test at the end of the academic semester. To defend their laboratory work, students must prepare a work report with completed tables, graphs, and conclusions. The defense takes place through communication between the student and the teacher individually or as part of a team. Students have the opportunity to receive up to 10 incentive points for completing work related to improving the material (lecture course and laboratory work, lecture notes, etc.) of the discipline. Semester assessment in the discipline "Multimedia Technologies in Radio Communications" is conducted in the form of a written test. A 100-point rating system and a university scale are used to evaluate the results of student learning.

8. Types of control and rating system for assessing learning outcomes

A student's grade for a discipline in a semester consists of points that they receive:

1) for current control in lectures (quizzes);

2) for completing and defending laboratory work;

3) for practical work;

3) for answers on the test.

Rating (weighting) point system and assessment criteria

1. Ongoing assessment in lectures

Weighting score – 2. The maximum number of points for all lectures is
$2 \cdot 14 = 28$ points.

Assessment criteria:

complete answer to a question or correctly solved task – 2 points;

incomplete answer to a question or partially correctly solved task – 1.75…1.25 points;

no answer to the question or unsolved task (solved completely incorrectly) – 1. 0.25 points;

- complete lack of preparation for the class – 0 points.

2. Laboratory work

The maximum weight score for one completed and defended laboratory work is 5. The maximum number of points for all laboratory work is equal to:

$9 \cdot 5 = 45$ points.

Assessment criteria:

a) Completion of work:

- all stages of the work have been completed – 5 points;
- more than 50% of the work has been completed – 4…3 points;
- less than 50% of the work has been completed – 2..1 points;
- the work has not been completed or has been

completed incorrectly – 1..0 points. b) Defense

of the work:

- the work report is prepared in accordance with the requirements and all questions are answered during the defense – 5 points;
- the report on the work is not formatted in accordance with the requirements and/or during the defense, answers to more than 50% of all questions are received – 4.5…3.5 points;
- the report on the work is not formatted in accordance with the requirements and/or during the defense, less than 50% of all questions were answered correctly – 3…1 points;

the report on the work is not formatted and/or during the defense, the student was unable to answer any questions – 0 points.

3. Work in practical classes

The maximum score for one fully completed practical class is 3. The maximum number of points for all practical classes is

$3 \cdot 5 = 15$ points.

Assessment criteria:

- complete answer to a question or correctly solved task – 3...2.5 points;

- incomplete answer to a question or partially correct solution to a task – 2.25...0.5 points;

- no answer to the question or unresolved task (completely incorrect solution) – 0 points.

4. Modular control

The maximum weighting for the entire MCR is 12 points.

Assessment criteria:

- complete answers to all questions – 12-11 points;

- incomplete answer to one question and complete answers to all other questions – 10-9 points;

- incomplete answers to two questions and complete answers to all other questions – 8-6 points;

- incomplete answers to all questions – 5..1 points;

- No answers to the questions asked – 0 points.

5. Penalty and bonus points

5.1. Bonus points:

- up to 10 incentive points are awarded for participation in the institute's academic competition in the discipline, modernization of laboratory work, and completion of tasks to improve teaching materials in the discipline.

5.2. Penalty points:

- for absence from a laboratory class without a valid reason – (-2) points;

- for not being prepared for practical classes – (-5) points;

- for failure to attend a test without a valid reason – (-5) points;

- for late defense (before the test) of each laboratory work – (-2) points for one work.

6. Calculation of the rating scale

Points and grades (R) for work during the semester

The total weight of control measures during the semester is: R = 28+

45 + 15+ 12 = 100 points.

The rating is communicated to students during the penultimate class of the semester.

A prerequisite for a student to receive a credit is a rating of

RD ≥60.

Students who have fulfilled all the conditions for admission to the exam and have a rating of 60 points or more receive a grade corresponding to their rating without additional tests.

Students who have fulfilled all the conditions for admission to the exam and have a rating of less than 60 points, as well as students who wish to improve their rating, must take the exam in the form of a test. In this case, the student's previous rating (except for points for semester individual training) is canceled, and they receive a grade based on the results of the test.

The condition for admission to the exam is the absence of uncredited laboratory work, DKR, practical tasks, and a student's starting rating of at least

RC = 40 points.

The sum of the rating points and the points for the test is converted into a test score for the discipline according to the table:

7. Test

During the test, students complete a written test. The test contains three theoretical questions and one problem. The maximum number of points for the test is 100 points. Each task contains three theoretical questions (tasks) and one problem. Each question (task) is scored out of 25 points according to the following criteria:

– "excellent", complete answer, at least 90% of the required information, performed in accordance with the requirements for the "skills" level (complete, error-free solution of the problem) – 25...21 points;

– "good", sufficiently complete answer, at least 75% of the required information, performed in accordance with the requirements for the "skills" level, or there are minor inaccuracies (complete solution of the task with minor inaccuracies) – 20...15 points;

– "Satisfactory," incomplete answer, at least 50% of the required information, performed in accordance with the requirements for the "stereotypical" level and some errors (task performed with certain shortcomings) – 12...1 point;

– "unsatisfactory", the answer does not meet the conditions for "satisfactory" - 0 points.

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Table of correspondence between rating points and university scale grades

Number of points	**Rating**
100-95	Excellent
94	Very good
84	Good
74-65	Satisfactory
64-60	Sufficient
Less than 60	Unsatisfactory
Admission requirements not met	Not admitted

9. Additional information on the discipline (educational component)

The material of the educational component is studied in lectures and in the process of independent work, with regular monitoring of students' knowledge and skills in lectures, practical and laboratory classes. Ongoing assessment of knowledge is carried out in lectures, practical and laboratory classes by conducting a 5-10 minute test at the beginning of the class and based on the results of tests. Final assessment of students' knowledge is carried out in a semester differential test. Theoretical material is taught on the basis of textbooks [1-5], and methodological guidelines for practical and laboratory work are provided to students at the beginning of the semester. Teaching this discipline requires a computer lab with modern, constantly updated technical equipment, providing each student with a separate workstation
– a set of basic personal computer devices. A local network, Internet access, and appropriate software are also required.

Description of material, technical, and informational support for the discipline

Computer lab, Matlab, etc.

Work program of the academic discipline (syllabus):
Compiled by Stepanov M. M.;
Approved by the PRE Department (Minutes No. 06/2024 dated 06/27/2024)
Approved by the methodological commission of the faculty/research institute (protocol No. 06/2024 dated 28.06.2024)