

The syllabus of the discipline
Mobile communication systems

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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	Mobile communication systems
Number of ECTS credits	8
Discipline structure (distribution by types and hours of study)	48 hours - 24 lectures, 16 hours - 8 practical classes, 32 hours - 8 laboratory classes, 16 hours - 8 consultations, 128 hours - homework, type of control: exam
Schedule (terms) of studying the discipline	3rd year, VI semester; 4th year, VII semester
Prerequisites for studying the discipline	Basic concepts of: 1. Fundamentals of circuitry 2. Fundamentals of systems theory 3. Fundamentals of information and communication technologies 4. Electrodynamics Know: theory, principles of construction and operation of circuit devices; theory of RC circuits; properties of sample circles and their main parameters; modern types of modulation of digital signals, structure of modulators and demodulators, efficiency of different types of modulation; signal generation theory; laws of signal propagation in devices (feeders) and atmosphere, taking into account urban conditions and subscriber mobility; the principle of operation of different antennas.
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: to know: modern and perspective directions of development of networks and systems of mobile communication; basic laws (models) of radio wave propagation; types and principle of operation of base and mobile station antennas; principles of construction and operation of transceivers; circuitry of functional devices of mobile communication systems; principles of construction, organization, operation and design of cellular and trunking communication systems. be able to: design and operate mobile communication systems.

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
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Description and content of the discipline

The purpose of the discipline is to provide students with knowledge, skills and abilities in the field of mastering the theoretical foundations of construction, operation and design of cellular and trunking systems of mobile communications, as well as familiarization with their technical characteristics and principles of operation.

Content

Part 1 (6th semester)

Content module 1. Propagation of radio waves (RRW)

1. Structural diagram of the radio communication system. The field of isotropic and directional emitters in free space. The concept of signal loss during SRH in free space and real conditions (the first transmission equation for communication on VHF). Region of space that is essential in SRS.

Topic 2. The impact of the troposphere under the condition of the SRS. Line of sight distance. SRS over the flat surface of the Earth. SRS over the uneven surface of the Earth. Features of SRS in urban and suburban areas. PPX models (Lee, Okamuri-Hachi, etc.). Fading signals, their classification, the cause of occurrence. Measures to combat fading.

Content module 2. Antennas.

Topic 1. Block diagram of antennas. Classification of antennas (omnidirectional and directional, single vibrators, antenna arrays). Antenna parameters.

Content module 3. Principles and devices for generating modulated signals (Radio transmitting devices (RPP))

Topic 1. Appointment of RRP. Main characteristics and properties.

RFI structures of base and mobile stations.

Topic 2. RPP heterodynes. Appointment, requirements for them. Stabilization of the frequency of local oscillators. Ways to stabilize the frequency. Digital frequency synthesizers (DSM). Structures and principles of work of CSM. The main characteristics of the CSM.

Topic 3. Types of modulation used in mobile communication systems. General information about the types of modulation. Their comparison. Structures of modulators and the principle of their operation.

Content module 4. Principles and signal processing devices (Radio receivers (RPrP))

Topic 1. Appointment. Components. Functions performed by RPrP. Structures of RPrP. Comparative characteristics of RPR structures.

Topic 2. The main indicators and characteristics of the RRP (selectivity, sensitivity, noise figure, etc.). Noise characteristics of RPR.

Topic 3. Input devices (VHP) RPrP. Appointment. The main indicators and characteristics of VHP. Schematic diagrams of VHP. Their features, principle of work.

Topic 4. Selective amplifiers (OS). Radio frequency amplifiers (PRCh). Appointment. Classification. The main characteristics and properties of the PFC. PFC schemes. Principle of operation.

Topic 5. Intermediate frequency amplifiers (IFA). Appointment. Main indicators and characteristics of SCP. Classification of UPC. SCP schemes. Principle of operation. PFC with high selectivity (with PCF, surfactant).

Topic 6. Low noise amplifiers. (MBP). Appointment. Types of MBP. Transistor and parametric MBPs. MBP schemes. Principle of operation.

Topic 7. Frequency converters (FC). Appointment. The main characteristics and properties of the inverter. The principle of frequency conversion. Transistor and diode inverters. FC circuits. Principle of operation.

8. Signal detectors used in mobile communication systems.

Phase detectors (PD). Appointment. main properties. FD types. Schemes of diode FDs, the principle of operation.

Detectors of phase-shift keyed signals. Coherent and non-coherent sensors. Structures of detectors and principle of operation. Methods and schemes for the formation of a reference coherent voltage.

Content module 5. Mobile communication systems (MCS).

Topic 1. Classification of mobile communication systems (MCS). main properties. The principle of organization and functioning of the CSF. multiple access methods (FDMA, TDMA, CDMA, spatial).

Topic 2. Fundamentals of frequency-territorial planning of cellular communication systems (CCS). Working area coverage methods, cell types, cluster, channel allocation methods between BTSs, full frequency utilization, etc. CVD efficiency. Ways to increase the capacity of cellular networks. So-channel interference.

GSM.

Part 2 (7th semester)

Content module 1. Digital cellular communication system (DCSS)

Topic 1. Generation of cellular communication. Comparative characteristics generations of cellular communication.

Topic 2. Main parameters of GSM 900, DCS 1800, PCS 1900, E-GSM standards. Network structure. Base station subsystems (BSS). BSS architecture. BSS functions. Base stations (BTS). BTS architecture. BTS features. BTS electrical settings and connection between them. base station antennas. Adaptive antenna arrays. Design features of BTS antennas. Switching subsystem equipment. mobile stations. MS classes. MS architecture. MS functions. MS Antennas.

Topic 3. Interfaces of the GSM standard. Frequency plan of GSM and E-GSM standards. Radio interface. The structure of the radio interface. Organization of radio channels. Physical and logical channels. The speed of data transfer in different parts of the network. TDMA frame structure.

Topic 4. Aspects of security. General description of safety characteristics. Authentication. Data privacy, etc. Reality module.

Topic 5. The effectiveness of the use of radio equipment. modulation. Perversion. Frequency jumps. Power management. Advance transmission. Interrupted transmission.

Content module 2. CSSS of ADC and JDC standards.

Topic 1. Main parameters of ADC and JDC standards. The structure of systems. Features of ADC and JDC systems. Fundamentals of designing cellular networks with TDMA / FDMA.

Content module 3. IS-95 CSSD.

Topic 1. Properties of broadband signals (BSS). Methods for obtaining SSS. Analysis of the transmitting and receiving device by the SSN. Evaluation of the gain in terms of signal/noise when using the SSN. Organization of multiple access by code division. Simplified structure of a multi-channel code division radio communication system. Basic parameters of IS-95. Structure of the IS-95 network. The functions are used in the IS-95 standard. Channels in the IS-95 standard.

Topic 2. Downline architecture. Types of channels, their purpose. Pilot, sync, call, and forward traffic channel structures.

Topic 3. Architecture of the "up" line. Types of channels, their purpose. Structure of access channels and reverse traffic. Power management. Relay transfer. Fundamentals of designing cellular networks of CDMA technology.

Content module 4. Prospects for the development of mobile communication systems.

Topic 1. Public feature of 3rd and 4th generation mobile communication systems.

Content module 5. Professional (trunked) mobile communication systems (TMZ)

Topic 1. General information. Principles of construction and architecture of TSMP. TSMS services. Digital trunking systems. TETRA standard systems. main properties. The principle of organization and functioning.

Content module 6. Paging systems (PRCS) (paging)

Topic 1. Principles of organization and functioning of paging communication. protocols. Methods for covering the service area. Paging networks.

Content module 7. Electromagnetic compatibility (EMS) in mobile communication systems.

Topic 1. main definitions of EMC. Sources and classification of mutual interference. Organization and methods for solving EMC problems. The essence of the problem of frequency planning.

Learning outcomes of higher education

As a result of studying the discipline, students must:

to know: modern and perspective directions of development of networks and systems of mobile communication; basic laws (models) of radio wave propagation; types and principle of operation of base and mobile station antennas; principles of construction and operation of transceivers; circuitry of functional devices of mobile communication systems; principles of construction, organization, operation and design of cellular and trunking communication systems.

be able to: design and operate mobile communication systems.

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

To evaluate the student's work during the semester, the total rating rating Q_{sem} calculated as the sum of grades for different types of classes and tests measures in accordance with the table below.

Part 1

Type of lesson / control measure	Rating
Lb № 1	7...13
Individual homework № 1	8...13
Pr № 1	7...13
<i>Control point № 1</i>	22...39
Individual homework № 2	10...13
Lb № 2, № 3	(7...12)x2 14...24
Pr № 2,3	(7...12)x2 14...24
<i>Control point № 2</i>	38...61
Total for the semester	60...100

Part 2

Type of lesson / control measure	Rating
Lb № 1, № 2, №3	(5...9)x3 15...27
Pr № 1,2	(7...9) 14...18
<i>Control point № 1</i>	29...45
Lb № 4, № 5	(5...9)x2 10...18
Pr № 3, № 4, № 5	15...27
Individual homework	6...10
<i>Control point № 2</i>	31...55
Total for the semester	60...100

The second part of the discipline (in the 7th semester) provides a combined exam. At this type of control is the final assessment of P_p calculated by the formula:

$$P_p = 0.6Q_{sem} + 0.4Q_{isp},$$

where Qsem - assessment for the semester on a 100-point scale, Qisp - score for the test on a 100-point system.

Ticket for the exam consists of two theoretical questions and one problem.

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. Hrudynskaia H.P. Rasprostraneniye radyovoln. – M.: Vyshcha shkola, 1975.- 279s.
2. Radyoreleinye y sputnykovye systemy peredachy. Uchebnyk dlia VUZov/ Pod red. A.S. Nemyrovskoho. – M.: Radyo y sviaz, 1986.- 392s.
3. Bohdanovych B.M., Okulych Y.N. Radyopryemnye ustroistva. – Mynsk: Vysheisha shkola, 1991.- 407s.
4. Proektyrovanye radyoperedatchykov: uchebn.posobye dlia vuzov / V.V.Shakhchylnian, M.S. Shumylyn, V.B. Kozыrev y dr. pod red. V.V. Shakhchylniana (4-e pererab. y dopol.) – M: Radyo y sviaz, 2000 – 656 s.
5. Emelianov V.V. Sotovaia sviaz. Chast 1. Uchebn. pos. – Kharkov: KhNURE, 2002, - 136s.

6. Emelianov V.V., Myroshnychenko A.Iu. Sotovaia sviaz. Chast 2. Uchebn. pos. – Kharkov: KhTURE, 2000, - 154s.
7. Emelianov V.V., Nazarenko V.V. Trankynhovaia radyosviaz. Uchebn. pos. – Kharkov: KhTURE, 2000, - 174s.
8. Emelianov V.V., Myroshnychenko A.Iu., Presniakov Y.N. Peidzhynhovaia sviaz, Uchebn. pos. – Kharkov: KhTURE, 1999, - 147s.
9. Yemelianov V.V. Konspekt leksii z dystsypliny «Systemy mobilnoho zviazku» Chastyna 1 «Poshyrennia radiokhvyl ta anteny» dlia studentiv vsikh form navchannia 6.050903 «Telekomunikatsii» - Kharkiv: KhNURE, 2017 – 172 s.
10. Yemelianov V.V. Konspekt leksii z dystsypliny «Systemy mobilnoho zviazku» Chastyna 2 «Radioperedavalni ta radiopryimalni prystroi» dlia studentiv vsikh form navchannia spetsialnosti 172 «Telekomunikatsii ta radiotekhnika» - Kharkiv: KhNURE, 2018 – 163 s.
11. Yemelianov V.V., Svyd I.V. Systemy stilnykovoho rukhomoho radiozviazku. Navch. posibnyk z hryfom MON Ukrainy. – Kh.: TOV «Kompaniia SMIT», 2011. – 336 s.
12. Bezruk V.M., Yemelianov V.V., Kryvenko S.A. Informatsiini merezhi zviazku. Ch.3 Merezhi mobilnoho zviazku: Navch. posibnyk – Kharkiv: KhNURE, 2011,- 420 s.

Supporting literature

13. Systemy mobylnoi sviazy: uchebn. posob. dlia vuzov / V.P. Ypatov, V.K. Orlov, Y.M. Samoilov, V.N. Smyrnov: pod red. V.P. Ypatova. – M.: Horiachaia lynyia – Telekom, 2003. – 272 s.
14. Halkyn V.A. Tsyfrovaia mobylnaia sviaz: uchebn. posobye dlia vuzov / V.A. Halkyn. – M.: Horiachaia lynyia – Telekom, 2007, - 432 s.
15. Antenno-fydernye ustroistva y rasprostraneniye radyovoln: uchebnyk dlia vuzov / H.A. Erokhyn, O.V. Chernyshev, N.D. Kozyrev, V.H. Kocherzhevskiy; pod red. H.A. Erokhyna.- (3-e yzd.) – M.: Horiachaia lynyia – Telekom, 2007, - 491 s.
16. Ratynskiy M.V. Osnovy sotovoi sviazy / M.V. Ratynskiy; pod red. D.B. Zymyna. – M.: Radyo y sviaz, 1998, - 208 s.
17. Klymash M.M., Pelishok V.O., Mykhailevych P.M. Tekhnolohii merezh mobilnoho zviazku – K.: Osvita Ukrainy, 2010, - 621 s.
18. Smohylev K.A. y dr. Radyopryemnyky SVCh. Voennoe yzdatelstvo Mynysterstva oborony SSSR, 1976, - 520 s.
19. Systemy podvyzhnoi radyosviazы / Pod red Y.M. Pyshkyna. – M.: Radyo y sviaz, 1986, - 328 s.
20. Sukhoputnaia podvyzhnaia radyosviaz. Knyha 1. Osnovy teoryy / Pod red. V.S. Semenykhyna y Y.M. Pyshkyna. – M.: Radyo y sviaz, 1990, - 430 s.

Methodical instructions for different classes

21. Metodychni vkazivky do praktychnykh zaniat z dystsyplin «Systemy mobilnoho zviazku» dlia studentiv usikh form navchannia napriamku 6.050903 – «Telekomunikatsii» / Uporiad. V.V. Yemelianov, S.A. Ivanenko – Kharkiv: KhNURE, 2016r.
22. Metodychni vkazivky do kursovoho proektuvannia po dystsyplini «Systemy mobilnoho zviazku» dlia studentiv vsikh form navchannia napriamku 6.050903 – «Telekomunikatsii» / Uporiad.: Yemelianov V.V., Svyd I.V. – Kharkiv: KhNURE, 2011. – 56 s.

23. Metodichni vказivky do laboratornykh robit z dystsypliny «Systemy mobilnoho zviazku» dlia studentiv vsikh form navchannia napriamu 6.050903 – Telekomunikatsii / Uporiad.: Yemelianov V.V., Svyd I.V. – Kharkiv: KhNURE, 2014, - 44 s.

Information support

Developed programs for laboratory work "Research of parameters of efficiency of cellular communication systems", "Research of parameters of model of cellular communication network", "Study and research of subsystem of base stations of cellular communication of the GSM standard", "Study and research of architecture of line up" "Cellular communication systems of the IS-95 standard", and also programs on designing of cellular communication networks of various standards.