**Questions for**

**entrance examination on speciality 05.13.13**

**‘TELECOMMUNICATION SYSTEMS AND COMPUTER NETWORKS’**

**2.1. Telecommunication systems**

**2.1.1 Spectral representations of signals.**

Vector representation of signals. Decomposition of periodic signals in Fourier series. Spectra of non-periodic signals. Fourier integral. Calculation of spectra of typical impulse signals. Correlation analysis of signals. Autocorrelation and mutual-correlation characteristics of signals. Connection of autocorrelation function with signal spectrum. Digital filters, basic methods of analysis and methods of their construction.

**2.1.2 Theory of optimal methods of signal reception on noise background.**

Kotelnikov's theorem. Kotelnikov's inverse theorem. Geometrical representations of signal and noise. Signal space. Signal reception as a statistical problem. Optimal reception and selection of signals on the background of noise. Potential noise immunity of reception of digital signals, probability of error for binary opposite signals. Probability of error at reception of multiposition signals. Bandwidth of the communication channel.

**2.1.3 Methods of noise-resistant coding in a communication channel.**

Elements of Shannon's information theory. Entropy as a measure of information quantity. Shannon's formula for the throughput of a communication channel with white noise. Source coding of digital messages. Optimal codes.

4.Coding of signals in a communication channel. Geometrical representation of code ensembles. Densest stacking codes. Throughput of a communication channel at finite time of signals observation.

**2.1.4 Communication channels.**

**2.1.3 Methods of noise-resistant coding in a communication channel.**

Elements of Shannon's information theory. Entropy as a measure of information quantity. Shannon's formula for the throughput of a communication channel with white noise. Source coding of digital messages. Optimal codes.

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**2.1.4 Communication channels.**

Hypothetical reference communication line of tone frequency. Requirements to the qualitative characteristics of the line. Methods of compaction and separation of synchronous and asynchronous channels in telecommunication systems: frequency, time, code. Methods of multistation access MDCHR, MDVR, MDKR in radio systems. Synchronisation of signals in communication channels. Synchronisation by carrier frequency, clock frequency of symbols. Analysis of the phase frequency autotuning system operation under the influence of signals and noise. Multibeam radio communication channels. Scattering function of the communication channel. Correlation intervals in frequency, time, space. Spaced reception. Interference protection and covert operation of radio channels. Fibre-optic and laser communication channels. Quantum noise and signal-to-noise ratio at the photodetector output. Basic characteristics of a fibre-optic communication line. Signal attenuation, coherence bandwidth of a fibre-optic communication line. Subscriber access channels (‘last line’). Methods of high-speed transmission of digital information via tone frequency communication channel. Methods of packet transmission of information over communication channels and networks. Packet-address time compaction of asynchronous digital channels with pulsating traffic. Traffic control in packet transmission channels and networks. Principles of construction of high-speed computer telecommunication networks and high-speed integrated service networks. Transmission of digital information over television channels.**2.1.5 Radio relay communication systems.**

Frequency ranges, functional schemes of radio relay systems. Frequency plans of radio relay communication lines. Peculiarities of radio signals propagation in RRL. Signal refraction and diffraction signal fades. Fast signal fades due to multipath propagation of signals and methods of combating fast signal fades. Methods of modulation and demodulation of signals in RRL. Use of multilevel amplitude and phase manipulation of signals in RRL. Basic characteristics of antenna-feeder devices used in radio relay communication. Peculiarities of tropospheric radio relay communication systems construction.

**2.1.6 Satellite telecommunication systems**

Hypothetical reference digital satellite communication link for fixed earth stations and its characteristics. Frequency ranges and frequency plans of satellite communication systems. Orbits of communication spacecrafts, service areas on the Earth surface. Features of radio signals propagation in satellite telecommunication systems. Flickers of radio signals, absorption of signals in rain, depolarisation of signals. Methods of calculation of energy potentials of radio lines. Optimal frequencies in space communications. Electromagnetic compatibility of satellite communication systems. Possibility of using the same frequency bands in different satellite communication systems**.**

**2.1.7. Cellular terrestrial radio systems of mobile and personal communications.**

Functional schemes of cellular terrestrial radio communication systems with mobile and personal terminals. Frequency ranges allocated to these systems, frequency plans of cellular communication systems. Features of radio signal propagation in cellular communication networks. Mechanisms of radio wave propagation, slow and fast signal fading, behaviour of median value of radio signal in a city. Okumura-Hata model of radio signal propagation. Calculation of energy potentials of radio lines. Multistation access with code division of channels in cellular communication systems. Beam splitting and addition in a multipath channel. Use of ‘Rake - receiver’ principles in multipath signal processing. Mutual interference from neighbouring cells in MDCR. Digital cellular communication systems. Examples: GSM, CDMA, WCDMA, others. Principles of construction of perspective high-speed multimedia cellular communication systems of the third and fourth generations. Selection of signal formats in packet transmission and modulation and coding methods in radio channel. Sensor networks.

**2.2. Computer networks**

**2.2.1 Technology of construction and topology of computer networks**

Architecture and topology of local networks: Basic topologies: bus, star, ring; IEEE 802.x standards: Ethernet, Token Ring, FDDI, FastEthernet, GigaEthernet; combined topologies; structured cabling systems and recommendations on topology selection. Network layer as a means of building distributed networks: Networks of networks: principles of interconnection of local networks with the help of network layer protocols; implementation of network layer in TCP/IP stack; characteristics of routers and multifunctional concentrators; application of ATM in local networks and for transmission of traffic of local networks; technologies Classical IP over ATM, LANE1, LANE2, MPOA. Application layers and network services: Name extension service, e-mail, file transfer service and FTP protocol, remote terminal and terminal services (Telnet), network file system (NFS), remote procedure execution (RPC), network printing**.**

**2.2.2. Technology of building territorial distributed networks.**

Basic principles and technical means of distributed networks organisation: Remote access and connection of local networks; interaction of different types of networks; construction of computer networks with the help of network equipment: hubs, bridges, switches, routers and gateways; peculiarities of bridges and routers operation in networks with protocols: X.25 and TCP/IP; Frame Relay and ATM. Organisation of virtual networks VLAN, VPN. Technology and means of WWW. Principles of organisation and types of territorial communications, remote access: Telecommunication channels: dedicated analogue and digital lines, channel compaction equipment and ‘last mile’ lines; wireless communication networks; channel layer protocols for remote access lines. Backbone wire, radio retransmission, fibre optic and satellite communication networks; digital communication networks with channel compaction hierarchy: ISDN, PDH, SDH.

**2.2.3. Equipment for local networks.**

Cabling systems (types, standards and main characteristics of cabling systems; structured cabling systems; cabling systems market; best products);

Hubs (types and main characteristics of hubs; stacked hubs; hub market; best products); Switches (types and main characteristics of switches; switch market; best products);

Routers and Layer 3 switches (types and main characteristics of routers; features of Layer 3 switches; router market; best products);

**2.2.4. Enterprise networking equipment:**

Access routers (types and main characteristics of area network access routers; area network access router market; best products); ISDN access devices (overview of access devices).

Modems (classes, types and main characteristics of modems; modem market; best products);

**2.2.5 Network software and operating systems.**

Network operating systems. OS functions on local resources management: Unix OS; Novell Netware; MS Windows NT; definition of local OS type; peer-to-peer OS and ‘client-server’ architecture. Network organization and types of services in a network operating system (OS): Message passing primitives; remote procedure calls; file servers and file services; process and processor management; memory management; file system functions; OS I/O management functions; OS resource sharing functions; network management protocols: SNMP and CMIP. **2.2.6 Corporate networks and security issues.**

1)Basic approaches to organizing inter-network communication: Gateway, multiplexing of protocol stacks, encapsulation, definition of network coordination levels, selection of resource access directions and routing, placement of interconnection facilities; Security problems in networks: Confidentiality, integrity and availability of data, basic security technologies; Secure channel protocols: SSL; IPSec; PPTP; Methods of network authentication: Authentication: password-based, using one-time passwords, certificate-based, protection at the level of transport subsystem.

**Literature**

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5.Computer networks: principles, technologies, protocols: textbook for universities / V.G. Olifer, N.A. Olifer - 3rd ed. - SPb.: Peter, 2009. - 957 с.

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12.Dmitriev mobile communication. St. Petersburg: St. Petersburg State University of Telecommunications named after Prof. M.A. Bonch-Bruevich, 1999.

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