FINAL STATE EXAM
RANGE of ISSUES

IN MASTER DEGREE PROGRAMME:

TELECOMMUNICATION TECHNOLOGY

Final state exam subjects in 2015/2016 academic year:

I. **Information and Communication Technology** (2 questions)

II. **Telecommunication technology** (2 questions from branch chosen by student during diploma thesis-)

A. Branch: **TELECOMMUNICATIONS**

B. Branch: **OPTICAL COMMUNICATIONS**

C. Branch: **RADIO COMMUNICATIONS**

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I INFORMATION AND COMMUNICATION TECHNOLOGY

1. Telecommunication and computer networks

a. OSI reference model (OSI model layers description).
b. Signaling in digital systems and networks (subscriber DSS1, network SS7 signaling).
c. Queueing theory (queuing system parts, Kendall classification, offered load and carried load modelling - Erlang B, Erlang C).
d. LAN, WAN and transport networks (Ethernet, Frame Relay, SDH, DWDM).
e. Access networks (xDSL, DOCSIS, PON variants, FFTx concept, WLAN, Bluetooth, Zigbee, WiMAX 2.0).
f. Mobile radio networks from 1 to 4 generation (frequency ranges, cell principles, NMT architecture, GSM, WCDMA/UMTS, LTE/SAE, GPRS/EDGE system, HSPA, PRB concept, OFDM).
g. TCP/IP protocols family (TCP/IP model architecture, relation to OSI model, examples and usage of protocols in particular layers).
h. Active network elements in computer networks and its functions - hub, switch, router (Detail description of functions of the elements, functions definition related to the OSI model, collision domain).

2. Digital signal processing

a. Definition of Signals and Systems; Basic Types and Operations with Signals. Frequency and Spectrum of Signal.
b. Analog and discrete signal spectrum – Fourier series expansion, Fourier transform, discrete Fourier transform, FFT and its properties. Spectrum of Basic types of signals. (Dirac impulse, unit impulse, harmonic signal, rectangular signal).
c. Typical DSP system (sampling, quantization, coding and signal reconstruction), sampling theorem, aliasing, leakage.
d. Cross-correlation and its meaning, autocorrelation and its meaning, convolution and its relation to LTI systems. Relation of correlation and convolution with Fourier transform and z-transform.
e. Linearity, stability, time invariance, causality of systems. Ideal filter, causal filter.
f. IIR and FIR filters. Typical properties and usage areas, IIR and FIR comparison.

3. Communication Network Practice II

a. Monitoring and maintenance of communication networks (data logging, SNMP protocol, RRDtool graphing tool, Netflow protocol).
b. AAA problematic – authentication, authorization and accounting in communication networks (LDAP protocol, Radius, Kerberos, SSO Single Sign-on Systems, SAML).
c. Communication tools (IRC communication, IM Instant Messaging, XMPP protocol, WebRTC communication via web browser).

4. Optical communication

a. Optical fiber function description, Single-mode and Multi-mode fibers and difference between them, Attenuation and dispersion in optical fibers, Splicing of optical fibers, Attenuation measurement.
b. Light sources for optical communications, LED principle, LED and LD difference, Properties of laser radiation.
c. Receivers for optical communications, Photodetector principle, Photodetector with PN junction, PIN, APD photodetectors, Catalog parameters of detectors.

5. Radio communication

a. Radio waves propagation (types and properties of radio waves, Frequency spectrum allocation, Fresnel zone, Doppler Effect, Diversite reception).
b. Radiocommunication chain (particular blocks description, modulation with carrier waves, capacity of radio channel).
c. Mobile radiocommunication systems 1 – 4 generations (basic architecture– differences, frequency band allocation, transmission rate).

II TELECOMMUNICATION TECHNOLOGY

Branch: TELECOMMUNICATIONS

1. VoIP

a. RTP (codecs and their parameters, RTP stream requirements calculation, security of RTP, packetization and de-jitter buffer).
b. H.323 (H.323 standard elements, RAS signaling, Fast Connect a H.245 tunneling, DRC a GRC model).
c. SIP (SIP elements, transactions and dialogs, methods and answers, SDP and offer/answer model, usage of SUBSCRIBE/NOTIFY methods, establishing call scenarios, ENUM).
d. VoIP Quality (speech quality evaluation approach, specific problems of IP telephony and its solutions, speech quality evaluation via E-model).

2. Advanced Network Technologies

a. MPLS Technology - basic characteristics. (label, LSP, LDP, LIB, LFIB)
b. MPLS VPN, MPLS – Traffic Engineering, AToM. (VRF, VPNv4, RT, tunnel label and virtual circuit label).
c. Differentiated Services, Priority marking of transferred data. (DSCP, IP precedence, ToS, CoS, Assured Forwarding).
d. Packet queueing methods, Traffic Shaping, Traffic Policing, WRED. (CBWFQ, LLQ, Traffic Shaping, WRED).

3. Security in communications

a. Secure communication basics (Steganography, cryptography, Kerckhoffs's principle, aims and methods of cryptography).
b. Modern cryptography systems (Symmetric and asymmetric cryptography, one-way functions and digital signatures, modular arithmetic, DH algorithm and RSA).
c. Block cyphers and stream cyphers characteristics (Stream and block cyphers, operate modus ECB, CBC, OFB, CFB and CTR).
d. Computer network security (typical attacks, packet filters, stateful firewall, IPS/IDS, VPN, IPsec, SSL/TLS a SSH).
e. Security in IP telephony (SRTP, SIPS, ZRTP, security risks in VoIP and their elimination).

Branch: OPTICAL COMMUNICATIONS

1. Optical communications I-III

a. Description of light – geometrical, electromagnetic and quantum optics. Description of ray, Wave plane, Photon, Photon energy. Fermat's principle, Snell law of refraction, Coherence, Polarization and light interference.
b. Optical fibers - History, Materials; Principle of light transmission inside optical fiber; Critical acceptance angle definition, Numerical aperture. Attenuation causes in optical fibers. Dispersion in optical fibers – modal, chromatic, polarization modal.

c. Light sources for optical communications – LED, LASER – physical principles, Mutual properties and differences. Spontaneous and stimulated emission of radiation, Inversion of population, Excitation.
d. Detectors for optical communications – photodiode, PIN, Avalanche photodiode – physical principles; SNR a BER.
e. Attenuation and dispersion measurement at optical lines (insertion loss method, cut back method, reflectometry method), BER measurement.
f. Wave equation and its solution for cylindrical fibers, Phase and group velocity of wave propagation, Modes of cylindrical waveguide, Normalized frequency.
g. Special materials and fiber optic structures, Fiber with shifted dispersion characteristic, Bending insensitive fibers, Bragg fibers, Microstructure optical fibers, Fiber optical sensors.
h. Nonlinear effects in optical fibers, Raman and Brilloiun scattering, Four wave mixing, Self-phase modulation, Solitons, Cross-phase modulation.
i. WDM systems – EDFA and semiconductor amplifiers, Filters, Splitters, Chromatic dispersion compensation.
j. Optical fiber and cables fabrication.
k. Optical fibers connecting – mechanical connections, splicing, demountable connections.
l. Fiber optic sensors, Division of FOS, Used principles, Point, integrated, distributed and quasi-distributed sensors.
m. Free space communications, Atmosphere characteristics, Types of free space networks, free space networks elements.

Branch: RADIO COMMUNIKATIONS

1. Radio networks, Radio communication technology

a. Radio waves propagation (radio waves types, fading, dispersion, refraction, reflection and diffraction of waves, frequency spectrum allocation, Fresnel zone, Doppler Effect, diversity reception, equalization).
b. Signal processing in radio networks (source coding, channel coding, interleaving, modulation, MIMO technology, OFDM).
c. Basic functions and concept of radio communication systems (multiple access, duplex, cellular structure, frequency band utilization increasing of network capacity, handover).
d. Antennas (basic distribution, types and properties; Yagi-Uda antenna, Impedance matching, Standing Wave Ratio, RF feeders and connectors).
e. WLAN (components of WiFi network, network types, spectrum technics, standards, frequency bands/radio channels).
f. Digital Video and Audio broadcasting (advantages/disadvantages, SFN networks, frequency bands).
g. GSM system (architecture, signal/burst processing, GPRS/EDGE technology).

h. UMTS system (WCDMA, chiprate, system architecture, power control, handover, HSPA).
i. LTE/SAE system (system architecture, scheduling, PRB unit, radio channel properties, Cyclic Prefix).
   Technology and construction of base stations and (antennas, measurement, hygienic limits, optimization)