Course title: ADVANCED COMPUTER NETWORKS

Lecturers	Asst. Prof. Nikola Ivković, Ph.D., Assoc. Prof. Ivan Magdalenić, Ph.D., Marko Peras, dipl. Inf., Asst. Prof. Igor Tomičić, Ph.D.
Language of instruction:	Croatian and English
Schedule:	60 teaching hours - 5 hours per week (2 hours lectures + 1 hour seminar + 2 hours laboratory work)
Study level	Bachelor
Study programme	Information / Business Systems
Semester	Winter
ECTS	6
Goal	The main goal of this course is to give students conceptual and practical knowledge in advance topics such as security, peer to peer architecture, wireless and mobile networks, multimedia streaming, routing, network management and network programming. This course develops critical thinking and promotes planning, making expert opinions and decisions based on the analytical approach, research, modelling, simulation and formal methods.
Content	1. NETWORK PROGRAMMING Socket API. Types of sockets. Transport service primitives. Data serialization problem. Clint-server architecture. Basic approaches in serving clients. Concurrent processing and communication. Versatile programming paradigms and libraries for network programming and multithreading. Testing and debugging of network applications. 2. SECURITY Attacks and countermeasures. Malicious code, botnet network, denial of service, attack intensification, intercept and capture, addresses spoofing, content modification and fabrication, resubmitting recorded packets. DNS attacks. Security requirements and types of attacks. Cryptography and its application in computer networks. Symmetric and asymmetric cryptography. Cryptographic hash functions. The technique of exchanging / cogenerating secret keys. Authentication protocols. Digital Signature. Certificate. Public Key Infrastructure. Application layer security, email security. Transport Layer Security and TLS. Network layer security (routing security, IPSEC…). Virtual private networks, security associations, security policy database. Wireless security. Types of firewalls and possible network

configurations. Application proxy. Access control lists. Demilitarized zone.Intrusion detection/prevention system.
3. PEER-TO-PEER ARCHITECTURE

Advantages and drawbacks of peer-to-peer architecture. Implementation challenges and possible solutions. Overlay network. Distributed hash tables.
4. ROUTING

Routing algorithms, autonomous systems, routing protocols (RIP, OSPF, BGP,…).

Broadcast, multicast, and anycast.

5. WIRELESS AND MOBILE NETWORKS

Wireless links, CDMA, hidden terminal problem, exposed terminal problem. Taxonomy of wireless networks. Wireless Local Area Networks and IEEE 802.11 standards. Bluetooth, ZigBee, RFID. Mobile access networks. Mobility, mobile IP, handoff, mobility in cellular networks.
6. MULTIMEDIA

Types of multimedia streaming applications. Disadvantages of the Internet for multimedia transmission and possible ways to mitigate them. Streaming stored audio and video, RTSP, HTTP for streaming stored multimedia, DASH. Content Distribution Networks (CDNs). Examples of streaming stored multimedia applications. Internet telephony (VoIP), real-time conversation. Adaptive reproduction delay. Packet loss recovery. Protocols: RTP, SIP, H.323. Quality of service (QoS) for multimedia transmission. Network support for multimedia, packet marking, isolation of traffic flows, connection admission. Scheduling mechanisms: FIFO, priority queuing, WFQ, policing mechanisms.
7. NETWORK MANAGEMENT
Introduction to network management. Internet network management framework, SMI, MIB, SNMP.

Preconditions	Computer Networks
Realization and examination	Classes: Lectures, seminars and laboratory exercises The lab practice is based on programming, using simulations, and network traffic analysis. Team projects are based on programming, simulation or formal verification and have research, development or educational aspects. Exam: Written and oral exam and seminars
Related courses	Similar courses at MIT.
Literature	Basic:

	Kurose, J.F.; Ross, K.W. Computer Networking: A Top-Down Approach. 7th edition, Pearson, 2017. Peterson, L.L.; Davie, B.S. Computer Networks: A Systems Approach 5th Edition, Morgan Kaufmann, 2011 Additional: Tanenbaum, A.; Wetherall, D. Computer Networks: Pearson New International 5th Edition, Pearson, 2013