STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Computer networks**	Code **1010331541010334959**

Field of study **Information Engineering**	Profile of study (general academic, practical) **(brak)**	Year /Semester **2 / 4**
Elective path/specialty **-**	Subject offered in: **Polish**	Course (compulsory, elective) **obligatory**

Cycle of study: **First-cycle studies**	Form of study (full-time,part-time) **full-time**

No. of hours								No. of credits
Lecture:	**45**	Classes:	**-**	Laboratory:	**30**	Project/seminars:	**-**	**5**

Status of the course in the study program (Basic, major, other) **(brak)**	(university-wide, from another field) **(brak)**

Education areas and fields of science and art **technical sciences**	ECTS distribution (number and %**)** **5 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	knows and understands, to an advanced degree, selected facts, objects and phenomena as well as methods and theories explaining the complex relationships between them, constituting the basic general knowledge in physics knows and understands selected facts, objects and phenomena, as well as methods and theories explaining the complex relationships between them, constituting the basic general knowledge in programming [K1_W02 (P6S_WG), K1_W05 (P6S_WG)]
2	**Skills**	can acquire information from literature, databases and other sources; integrate the obtained information, make their interpretation, draw conclusions and formulate and justify opinions; formulate and solve complex and unusual problems, perform tasks in conditions that are not fully predictable (...) is able to prepare documentation of an engineering task and discuss the results of this task (...) can use environments and programming platforms to write, execute and test the code of simple programs in programming languages (...) [K1_U01 (P6S_UW)][K1_U03 (P6S_UK)][K1_U10 (P6S_UW)]
3	**Social competencies**	is willing to take care of the tradition and achievements of the computer scientist profession; is aware of the importance and understands the non-technical aspects and effects of the computer science engineer activity and the related responsibility for the decisions made and for compliance with the ethics of the profession [K1_K02 (P6S_KR)]

Assumptions and objectives of the course:

The main objective of the course is to provide the student with the knowledge on transport- and application-layer technologies and the corresponding practical skills that one needs to acquire in order to be able to effectively design, implement and evaluate modern Application Programming Interfaces (APIs): Web APIs, SOAP-based web services, JSON Web APIs and REST web services. The course is aimed at presenting advanced computer network technologies - those already widely used (in particular in Internet) and those regarded as the so-called Future Internet technologies. In correspondence to the recent advances in Web technologies, the scope of the course includes various aspects of the interdependence of HTTP and a Web API, enabling the student to understand the key technologies enabling communication between components of distributed systems (such as ERP and SOA systems). The scope of the course includes technologies enabling effective operation of multi-service heterogeneous networks with a focus on dynamic routing protocols, fairness enforcement frameworks and Quality of Service (QoS) management techniques.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Student has organized knowledge with theoretical foundations of computer networks. - [K1_W07 (P6S_WG)]

2. Student has organized knowledge with theoretical foundations of Internet technologies. - [K1_W11 (P6S_WG)]

3. Student has organized knowledge with theoretical foundations of teleinformatics, protocols and services in telecommunication networks. - [K1_W15 (P6S_WG)]

Skills:

1. Student is able to do critical analysis of computer hardware operations, operating system and computer networks. - [K1_U11 (P6S_UW)]

2. Student is able to carry out work with web sites and Internet services. - [K1_U15 (P6S_UW)]

Social competencies:

1. Student understands and is aware of the importance of nontechnical issues related to computer engineer activity. Student understands the responsibility associated to his engineering decisions. - [K1_K02 (P6S_KR)]

Assessment methods of study outcomes

Lecture: final exam (verifiacation of the knowledge acquired during lectures and evaluation of the web service design skills).

Laboratory: exercises results assesment, reports assesment.

Course description

Lecture

The topics of the lecture include: active queuing management techniques for IP networks, Quality of Service (QoS) management techniques, fully dynamic routing (including Optimized Link-State Routing), network-layer resource optimization techniques (multi-path routing and its influence on QoS, Max Weight Scheduling technique, backpressure principle, IntServ and DiffServ models, RSVP protocol), effectiveness of transport-layer protocols (versions of TCP: Reno, Vegas, FAST, TCP delayed reordering technique), network resource optimisation from application-layer perspective (differences between file transmission and audiovisual streaming, TCP flow control vs UDP/RTP+RTCP flow control, adaptive streaming, application-layer flow control), various fairness models (reverse engineering of TCP utility, delay-aware Network Utility Maximization, multi-service fairness), interdependence of transport-layer and network-layer functions and protocols, cross-layer network functions and protocols optimisation, IP network operation stability, new types of wireless networks (wireless mesh networks, mobile ad-hoc networks (MANET), wireless multi-hop networks, heterogeneous networks, fully dynamic routing in wireless multi-hop networks), selected important research activities conducted in EU and USA in the area of Future Internet technologies, interdependence of transport-layer and application-layer protocols (in particular TCP and HTTP), application of different features of HTTP in modern Applicaton Programming Interfaces (APIs), various aspects of the relationship between HTTP and a Web API, SOAP-based web services, JSON Web APIs and REST web services, technologies and standards supporting resource modeling and building formal definitions of SOAP-based and RESTfull web services (including WSDL and OpenAPI), recent advances in technologies for web-based distributed systems (including ROA, microservices), similarities and differences between web services and Web APIs, web services and Web APIs as the key means for communication between components of distributed systems.

Teaching methods:

- Presentation of the theory with frequent references to relevant practical examples of software implementations,
- Lecture with multimedia presentation and presentations of Python programming language source code examples with their execution and rapid development/modification,
- Students being asked questions during the lectures in order to provoke discussions.

Laboratory

The topics of the laboratory exercises include: static routing in a multi-path network, dynamic routing - RIP and OSPF protocols, the impact of QoS parameters on effectiveness of TCP and flow control optimisation, text-based application-layer protocols, servers and clients (Telnet, FTP), HTTP protocol (Apache Web server setup, HTTP methods, status codes and headers, HTTP security (HTTPS), cookies, URL rewriting, virtual sessions), WSDL-based rapid development of SOAP-based web services, statefull and stateless SOAP-based web services (interdependence of SOAP and HTTP), RESTfull web services and JSON-based Web APIs.

Teaching methods:

- Individual work on the system (based on a script of the laboratory exercise),
- Work on configuration and experimentation in a network environment composed of multiple virtual machines,
- Work on open source tools and software components (including those developed in Poznan University of Technology research projects) made available to students to support their work,
- At the end of each class an evaluation of the results made by the lecturer,
- At the end of the semester preparation of the report on the implementation of all the laboratory tasks.

2017 update

A major modification of the whole course description and the bibliography has been made. In particular several new topics have been introduced, including: JSON Web APIs and REST web services, technologies and standards supporting resource modeling and building formal definitions of SOAP-based and RESTfull web services (OpenAPI), recent advances in technologies for web-based distributed systems (including ROA, microservices), similarities and defferences between web services and Web APIs, web services and Web APIs as the key means for communication between components of distributed systems.

Basic bibliography:

Additional bibliography:

Result of average student's workload

Activity	Time (working hours)
1. Lectures	45
2. Laboratory	30
3. Consultations and exam	10
4. Preparation for laboratory exectises	35
5. Laboratory reports preparation and exam preparation	30

Student's workload

Source of workload	hours	ECTS
Total workload	150	5
Contact hours	75	3
Practical activities	65	2