COURSE DESCRIPTION CARD - SYLLABUS

Course name
Telecommunication network design [S2EiT1E-TIT>PST]

Course

Field of study
Electronics and Telecommunications

Year/Semester
1/2

Area of study (specialization)
Information and Communication Technologies

Profile of study
general academic

Level of study
second-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

The student shouldknow the basics of traffic engineering, queuing theory, services, devices, management systems, network protocols and telecommunication techniques used in telecommunication and computer networks. Be able to use known mathematical analysis, algebra and theory of probability concepts to solve basic problems in electronics and telecommunication. Should also demonstrate responsibility and professionalism in solving technical problems.

Course objective

The aim of the course is to familiarise students with the fundamentals of analysis, dimensioning, optimization and design of network systems.

Course-related learning outcomes

Knowledge:
1. Has a systematic knowledge, with necessary mathematical background, of traffic theory and traffic engineering; of design, dimensioning and optimization of networks and network systems.
2. Has a systematic practical knowledge of designing ICT networks.

Skills:
1. Is able to use already known mathematical models and methods to analyze and design telecommunication devices and systems.
2. Is able to analyze, design, construct and exploit advanced telecommunications systems and various networks and devices which are part of them, ensuring that the designed systems and networks will have required technical parameters.

Social competences:
1. Is aware of the limitations of his/her current knowledge and skills; is committed to lifelong learning.
2. Demonstrates responsibility for designed telecommunication systems. Is aware of the hazards they pose for individuals and communities if they are improperly designed or produced.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Knowledge acquired during the tutorials is verified on the basis of a test. Students solve 3-5 tasks, scored differently depending on the level of difficulty of the problems. Passing threshold: 50% of points. Depending on the results, the scoring may change.
Knowledge acquired during lecture is verified on the basis of a test. The test includes 20-30 equally scored questions. Each question has 4 answers, one of which is true. Passing threshold: 50% of points (correct answers). Depending on the results, the scoring may change. In the case of a small number of students, the oral exem is preffered. Questions are asked by the lecturer or drawn from a collection of 20 issues known to students and passed on during the lecture. Each answer to a given question is rated on a scale of 2 to 5 and the final result is the average of the scores for individual answers.

Programme content

The program covers issues in the field of traffic engineering, modeling, optimization and design of ICT systems: fundamental notions of traffic engineering, mathematical foundations of modeling and optimization of network systems, modeling and dimensioning of single-service systems, mathematical fundamentals of modeling multidimensional systems, modeling and dimensioning of fully avaiable multiservice systems; state-dependent systems, Internet modeling, basic queuing models, multi-service queueing systems, TCP/IP resource dimensioning.

Course topics

1. Fundamental notions of traffic engineering: traffic and traffic intensity units; Kinds of network systems: loss systems, queueing systems; quality of service parameters; busy hour; traffic matrix; levels of network analysis; traffic forecasting.
2. Mathematical foundations of modeling and optimization of traffic systems: call stream and service stream in telecommunication systems; Markov processes; interpretation of the process solution; occupancy distribution of resources;
3. Modeling and dimensioning of single-service systems: models of full-availability resources; Erlang model; Engset model; Pascal model; non-full-availability resources models; Erlangs ideal grading; application of models for network resource dimmensioning.
4. Overflow theory: overflows in telecommunication and computer networks; overflow traffic parameters; dimmensioning of resources with overflow traffic: equivalent random traffic method, Hayward's equivalence method; comparison of call routing strategies.
5. Mathematical fundamentals of multidimensional systems modeling: two-dimensional Erlang distribution; micro-states and macro-states; reversibility of multi-dimensional Markov processes; product form solution; process calibration; recurrence notation of multi-dimensional Erlang distribution; Erlang-Engset distribution; convolution algorithms.
6. Modeling and dimensioning of multi-service systems; multiservice model of full-availability resources; Kaufman-Roberts distribution; application of model for network resource optimalisation and dimensioning; generalisation of the model for Erlang, Engset and Pascala traffic mixture.
7. Modelling and dimensioning of multi-service state-dependent systems: state-dependent systems; Markov process in state-dependent systems; systems with reservation; single- and multi-threshold systems; threshold systems with hysteresis; limited availability resources.
8. Basic queuing models: Kendall's notation; Little's theorems; M/M/1 and M/M/N systems with finite

and infinite queue; M/G/1 system; priorities; TCP/IP nodes dimensioning - M/G/R PS model; open and closed queueing networks; Jackson"s theorem; fundamentals of queueing networks dimensioning; delay analysis.
9. Modeling of multi-service queueing systems: multi-service server, resource division algorithms; multi-service gueueing models; sigmaM/sigmaM/C/C+U/sdFIFO model; comparison of queueing systems for various resource division algorithms.
9. Modeling of TCP/IP systems: equivalent bandwidth; traffic sources of packet streams: IPP, IBP, MMPP models; self-similarity in communication and computer networks, evaluation of self-similarity pnenomenon in networks; basic bandwidth unit and TCP/IP network discretisation.

Teaching methods

1. Lecture: multimedia presentation illustrated with examples.
2. Tutorials: multimedia presentation illustrated with examples; solving problems given by the teacher.

Bibliography

Basic
1. Stasiak M., Głąbowski M., Zwierzykowski P.: Modeling and Dimensioning of Mobile Networks: from GSM to LTE, John Wiley and sons Ltd., January 2011.
2. Iversen V.B., Teletraffic engineering and network planning, Technical University of Danmark, DTU, 2015 (available free on the net).
Additional
1. Teaching materials for lectures available to students in the form of pdf files.
2. Moscholios I.D., Logothetis M.D., Efficient multirate teletraffic losss models beyond Erlang, John Wiley and sons Ltd., 2019.

Breakdown of average student's workload

	Hours	ECTS
Total workload	90	3,00
Classes requiring direct contact with the teacher	55	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	35	1,00