Networks Theory

Academic Year: (2019 / 2020) **Review date: 15-05-2020**

Department assigned to the subject: Telematic Engineering Department

Coordinating teacher: SERRANO YAÑEZ-MINGOT, PABLO

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Algebra and Calculus fundamentals
- Basic knowledge of probability and statistics
- Basic knowledge of communication networks
- Programming

OBJECTIVES

The goal of this course is to allow the student knowing the basic foundamentals to be able to model and analize performance, as well as design and dimention, communication networks, considering both packet switching and circuit switching. To this aim, the student must acquire a certain knowledge and develop a number of compentences

With respect to knowledge, the student should be able to

¿ Understand the basic results form Markov Chain theory (in particular, Queueing Theory), as a modeling and performance assessment tool for communication netorks and protocols.

¿ Understand the use and limitations of the different results from classic queueing theory when modeling communication networks.

¿ Formulate dimensioning problems, and solve them, being aware of the different analytical tools available.

¿ Develop and use simulation tools to assess performance of communication networks, and to optimize them.

With respect to competences, the outcome of the course can be classified in two different groups, one related to particular competences closely related to the course specific, and another set related to the degree¿s program outcomes (PO¿s).

Concerning specific competences, the student should be able to

¿ Apply Markov Chain theory to analyze networks performance

¿ Formulate and solve optimization and dimensioning problems

¿ Design and perform simulations-based experiments, to solve performance analysis and dimensioning problems. This will require processing and analyzing simulaiton results.

¿ Develop the basic components of a simulation tool in order to analyze performance of communication networks.

Concerning the competences related to the degree¿s program outcomes, after this course

- The student will be provided with a ¿bird¿s view¿ of the problem of performance analysis of communication networks (PO i)
- He/she will be able to program/use analytical and simulation tools for performance assessment and network design (PO a, b)
- Will be develop teamwork abilities, to fulfil the requirements of the analytical and simulation asignments
- Make extensive use of the technical literature available
- Be able to identify, formulate, and solve design problems related to communication networks (PO e)

DESCRIPTION OF CONTENTS: PROGRAMME

The contents are divided as follows:

1. Introduction to performance analysis of communication protocols and networks, as well as simulation tools. Review of basic statistic concepts, including the exponential random variable and Poisson

arrivals.
2. Markov Chain: discrete-time and continuous-time. Use of MC as a modeling tool.
3. Birth and Death process as a particular case of Markov Chain. Queueing theory.
4. Introduction to the analysis of networks of queues, advanced systems, and dimensioning and optimization.

LEARNING ACTIVITIES AND METHODOLOGY

The learning activities and methodology will be based on the following:

1) Lectures: in these sessions students will be presented with the theoretical concepts related to the course¿s program (as well as some basic examples). They will be provided also with supplementary material, e.g., supporting slides, seminal papers. (PO a, i)

2) Laboratory sessions: in these, students will use modeling and simulation tools to further understand the key concepts described during lectures, as well as to use some standard tools for network dimensioning and to use simulations for performance assessment (PO a, b, e)

3) Exercises sessions with the teacher: these sessions will be devoted to problem formulation and solving, where students will discuss their results from the proposed homework, supported with teacher¿s guidance (PO a, e)

ASSESSMENT SYSTEM

The scoring will consist of:

- Final: 60%. Here, students will prove their understanding of key concepts of performance analysis (PO i), and will prove his/her ability to formulate a given problem using the modeling tools described (PO e) and solve it (PO a).

- Partial and laboratory evaluation: 40%. Short exercises will be performed along the lectures, and students will be timely provided with their marks so they can assess their own performance towards the final exam (PO a, e, i); after some lab. sessions students (arranged in teams) should deliver a written memory, and a ¿real-time¿ evaluation about their ability to use the software tool will also be performed (PO a, b). This evaluation is not compulsory.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- Mor Harchol-Balter Performance Modeling and Design of Computer Systems: Queueing Theory in Action, Cambridge University Press, 2013

ADDITIONAL BIBLIOGRAPHY

- Dimitri P. Bertsekas, Robert G. Gallager Data Networks, Prentice Hall, 1992

- José Alberto Hernández, Pablo Serrano Probabilistic models for computer networks: Tools and solved problems, Lulu.com, 2015

BASIC ELECTRONIC RESOURCES

- Pablo Serrano y José Alberto Hernández . Una introducción amable a la teoría de colas: https://www.it.uc3m.es/pablo/teoria-colas/