Performance Analysis of Computer Systems and Networks

1. **Course number and name:** 020PSRES4 Performance Analysis of Computer Systems and Networks.

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours

3. **Name(s) of instructor(s) or course coordinator(s):** Marc Ibrahim

4. **Instructional materials:** Professor textbook and slides, exercise sheets

5. **Specific course information**
   a. **Catalog description:**
   This course proposes the use of mathematical tools such as stochastic processes and optimization for modeling, performance analysis, and dimensioning of computer systems and networks. It introduces link multiplexing and dimensioning; Poisson process to model multiple access; Markov chains; M/M and M/G queueing systems; Queuing networks; Convex optimization; Resource optimization in networks; Performance evaluation by simulation and real network measurements. This course focuses on the application of these tools on real problems and the use of digital tools to solve these problems.

   b. **Prerequisites:** 020PRBNI4 Probability or 020AL3CI4 Algebra 3

   c. **Required** for CCE Telecommunication Networks option students; **Selected Elective** for CCE Software Engineering option students

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   - Identify the main parameters and metrics related to the performance analysis of networks and computer systems.
   - Analyze single and multiple queues systems, with or without priority.
   - Analyze queueing networks.
   - Use Queueing theory and Markov processes to model and measure the performance of systems.
   - Model, analyze performance of, and dimension communication networks and computer systems.

   b. **PI addressed by the course:**

PI	1.1	1.2	1.3	6.2	6.3	6.4
Covered	x	x	x	x	x	x
Assessed		x	x			

7. **Brief list of topics to be covered**
   - Introduction to teletraffic theory for modeling computer and telecommunication systems
   - Link dimensioning using applied probability tools and numerical simulation
   - Modeling and performance analysis of multiple access protocols such as Aloha and CSMA using Poisson process, with LoRaWAN use case
   - Traffic analysis
   - Markov chains for performance analysis
     a. Introduction to continuous time Markov processes. Infinitesimal generator and stationary distribution
     b. Learn how to use Markov processes in modeling real-world problems
     c. Applications to problems related to communication and computer systems: advanced queueing systems, computer memory optimization, etc.
   - Introduction to queueing theory
   - M/M/1 and M/M/1/N queues analysis. Application to delay and loss analysis in packet switching networks and other engineering problems
   - M/M/N/N queue analysis. Erlang-B formula for resources dimensioning in loss-based systems. Applications
   - M/M/c queue analysis and application to network elastic and real-time traffic modeling
   - M/G/1 queue analysis
   - Queueing networks
   - Introduction to convex optimization
   - Capacity design in packet switched transport networks by applying queueing and optimization.
   - Resource allocation and optimization
   - Lab sessions for network measurements