Performance Analysis of Computer Systems and Networks

1. **Course number and name:** 020CSRES4 Performance Analysis of Computer Systems and Networks.

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

3. **Instructor's or course coordinator's name:** Marc Ibrahim

4. **Text book:**
   a. **Other supplemental 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 the Poisson processes; The processes of birth and death; Basic M/M queues; Discrete and continuous Markov processes; Queuing networks; Priority queueing and scheduling strategies; Traffic patterns in networks; Performance evaluation by simulation. This course focuses on the application of these tools on real problems and the use of digital tools to solve these problems.

   b. **Prerequisites:** 020PROES1 Probability and Statistics

   c. **Required:** Elective for CCE students; required for CCE telecommunication networks option students

6. **Specific goals for the course**
   a. **Specific outcomes of instruction:**
      - Identify the main parameters and metrics related to the performance analysis of systems, and particularly 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. **KPI addressed by the course:**

KPI	a1	a2	e1	e2	e3	k1	k2
Covered	x	x	x	x	x	x	x
Assessed	x	x			x	x	x

Give Feedback							

7. Topics and approximate lecture hours:

- Introduction to teletraffic theory for modeling computer and telecommunication systems (1 lecture)
- Link dimensioning using applied probability tools and numerical simulation (1 lecture)
- Poisson process and birth-death process (1 lecture)
- Modeling and performance analysis of multiple access protocols such as Aloha and CSMA (1 lecture)
- Introduction to queueing theory and M/M queues modeling using birth-death process (1 lecture)
- M/M/1 and M/M/1/N queues analysis. Application to delay and loss analysis in packet switching networks and other engineering problems (4 lectures)
- M/M/N/N queue analysis. Erlang-B formula for resources dimensioning in loss-based systems. Applications (2 lectures)
- M/M/c queue analysis and application to network elastic and real-time traffic modeling (2 lectures)
- Markov processes for performance analysis (5 lectures)
    a. Quick reminder of discrete time Markov chain
    b. Introduction to continuous time Markov processes. Infinitesimal generator and stationary distribution
    c. Learn how to use Markov processes in modeling real-life problems
    d. Applications to problems related to communication and computer systems: advanced queueing systems, computer memory optimization, etc.
- Open and closed queueing networks: (3 lectures)
    a. Product form networks
    b. Applications: mobility modeling in wireless networks, computer processes modeling, etc.
- Capacity design in packet switched transport networks by applying queueing and optimization (3 lectures)
- M/G/1 queue analysis (2 lectures)
- Priority queueing (2 lectures)