University of Jordan
School of Engineering
Electrical Engineering Department
1st Semester – A.Y. 2016/2017

Course: Analysis of Communication Networks – 0903723 (3 Cr. – Core Course)

Instructor: Dr. Mohammed Hawa
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Office Hours: will be posted soon

Course Website: `http://www.hawa.work/courses/723`

Catalog Data: Introduction to queueing theory and traffic engineering. Markov chains, steady-state and balance equations. Continuous and discrete arrival models. Basic queueing systems. Erlang formulas. Applications to telephony systems and data networks, performance parameters (blocking probability, delay, throughput and reliability). Systems with vacations, priority systems, polling and reservation systems. Network simulation. Project.

Prerequisites by Course: **EE 0903720 – Random Variables and Stochastic Processes** (pre-requisite).

Prerequisites By Topic: Students are assumed to have a background in the following topics:

- Random variables and probability theory.
- Basics of stochastic processes.
- Fundamentals of Calculus and basic mathematics.

Textbook: **Probability, Markov Chains, Queues, and Simulation: The Mathematical Basis of Performance Modeling by William J. Stewart, Princeton University Press, 2009.**

References:

- *Queueing Systems Volume I: Theory* by Leonard Kleinrock, John Wiley & Sons, First Edition, 1975.
- *Fundamentals of Queueing Theory* by Donald Gross, John F. Shortle, James M. Thompson, and Carl M. Harris, Wiley, Fourth Edition, 2008.
- *Computer Networks and Systems: Queuing Theory and Performance Evaluation* by T. G. Robertazzi, Springer Verlag, Third Edition, 2000.
- *Probability and Statistics with Reliability, Queuing and Computer Science Applications* by Kishor Shridharbhai Trivedi, Wiley-Interscience, Second Edition, 2001.
- *Data Networks* by Dimitri Bertsekas and Robert Gallager, Prentice Hall, Second Edition, 1992.
- OPNET network simulation program.

Schedule & Duration: 16 Weeks, 30 lectures (75 minutes each) plus exams.

Minimum Student Material: Textbook, class handouts, scientific calculator, and an access to a personal computer.

Minimum College Facilities: Classroom with whiteboard and projection display facilities, library, computational facilities with OPNET simulation program.

Course Objectives: The overall objective is to introduce the student to the basics of queueing theory and network performance evaluation. The course develops a conceptual framework for modeling and analysis of different communication networks (both circuit-switched and packet-switched). It also shows how to set up such models and how to use them in the performance analysis of communication systems (performance parameters of special interest include blocking probability, delay, throughput and reliability). The course also develops computer simulation skills as a practical alternative to analyzing more complex systems.

Course Learning Outcomes:

Upon successful completion of this course, a student should:

1. Understand how to use models to analyze queueing phenomena and develop queueing solutions.
2. Become familiar with scheduling problems and algorithms.
3. Be able to analyze continuous and discrete-time Markov chains.
4. Learn how to perform simulations of a packet-switched or circuit-switched network.

Course Topics:

	Topic Description	Hrs
1.	Introduction to Queueing Theory and its Applications.	**1**
2.	Markov Chains: Periodicity, Irreducibility and Recurrence.	**2**
3.	Analysis of Discrete-Time Markov Chains (DTMC): steady-state probabilities, state transition probabilities, Global Balance and Local Balance Equations.	**2**
4.	Analysis of Continuous-Time Markov Chains (CTMC): Global Balance and Local Balance Equations.	**2**
5.	Introduction to Statistical Arrival Models: Poisson Arrivals.	**2**
6.	Continuous-Time Birth/Death Process.	**2**
7.	The Queueing Systems: M/M/1, M/M/∞, M/M/S/S and M/M/S.	**3**
8.	Performance Measures.	**2**
9.	Loss-system Analysis and Blocking Probability (Erlang-B and Erlang-C).	**2**
10.	Applications to Telephony Systems and numerical examples.	**2**
11.	M/M/1/N and M/G/1 Queueing Systems (P-K Equations).	**3**
12.	Applications to Data Networking Systems (new performance measures).	**2**
13.	**Midterm Exam**	**2**
14.	M/G/1 system with Vacations and the concept of Residual Life.	**2**
15.	Priority Queueing Systems.	**3**
16.	Polling and Reservation Systems (IEEE 802.11).	**2**
17.	More Statistical Arrival Models: Bernoulli Arrivals (Geometric Inter-arrival).	**2**
18.	Discrete Queueing Systems (Geo/Geo/1, Geo/D/1/N).	**2**
19.	More advanced applications (e.g., random-access protocols; routing protocols, switching in data networks).	**2**
20.	Data Network Simulation	**2**

Ground Rules:

Attendance is required and highly encouraged. Students are expected to be punctual, alert, and prepared for class. Students will be considerate of other students, which includes being quiet for the duration of the class period except when he or she has something to contribute. Students are encouraged to ask questions in class in an orderly manner. Cellular phones are not allowed in class.

All exams (including the final exam) should be considered **cumulative**. Exams are closed book. No scratch paper is allowed except for a single sheet of Equations. You will be held responsible for all reading material assigned, even if it is not explicitly covered in lecture notes. Problems must be worked in detail in order to receive full credit. Students may use calculators during exams. Laptop computers and tablets are not allowed, though.

No makeup exams will be allowed. In case of illness and in rare cases of other conflicts with scheduled examinations, students with documented excuses must see me within one week before or after the exam.

Academic misconduct will not be tolerated. It will result in a failing grade and may result in further disciplinary action by the University.

Assessments:

Exams, Quizzes, Projects, and Assignments.

Grading policy:

Midterm Exam	**30 %**
Simulation Project	**30 %**
Final Exam (Comprehensive)	**40 %**
Total	**100%**

Last Updated:

September 2016