University of Tehran
School of Electrical and Computer Engineering

Course	Performance evaluation of computer systems		
Course type, level, credit	Elective	Graduate	3 units
Field, Major	Computer Engineering	Software, Hardware, Information Technology	
Co-requisite(s)	-		
Prerequisite(s)	Basic Statistics and Probability, Computer Networks		
Prerequisite by topic	Basic probability, basic concepts in networking.		
Goals	The aim of this course is to present probability, stochastic process, queueing theory and simulation techniques as viable tools to model and study the performance of computer systems and communication networks. The students will be introduced to classical tools and methodologies in probability theory and stochastic modeling as well as simulation techniques, all of which are essential tools for students to conduct advanced research in the area of computer and network performance modeling and analysis. Students benefit from a collection of illustrative examples that exhibit the skills required to model, analyze, and design large-scale systems with low cost and high performance.		
Outcome	Upon successful completion of the course, students will be able 1. Apply simulation techniques to develop models of computer and communication systems 2. Apply queueing-based models to characterize computer and communication systems 3. Use appropriate analytic tools to compute performance measures of interest (e.g., delay, throughput) for a given queueing system 4. Design (or choose) the system parameters (e.g., server or link capacity) to achieve a given level of performance 5. Evaluate the relative merits of alternative system design solutions 6. Engage in research in the field of performance analysis and evaluation		

Topics	1. Importance of system analysis and performance evaluation and overview of the important measures of performance of computer networks and systems. 2. Measurement techniques and tools. 3. Probability theory and statistics: Probability Theory Review Laplace & z - transform Review Inequalities: Markov, Chebyshev, Chernoff Limit laws: Sequence of random variables Convergence of sequence of random variables: Convergence in probability, almost sure convergence, convergence in norm, convergence in distribution Law of large numbers (weak and strong) 4. Stochastic processes: Discrete-Time Markov Chain Continuous-time Markov Process Birth Death Process Poisson Process, PASTA Renewal process 5. Queuing theory and models: Little's Law M/M/1 Queueing System Simple Markovian Queueing System and Server model (Markovian Arrival Process / Coxian Distributions) M/G/1 Queueing System, Vacation, Priority Queueing Busy period analysis and its applications in calculating the distribution of : waiting time in queue sojourn time in system the number of customers in queue and system, Queueing Networks /Jackson, MVA, BCMP 6. Simulation basics and techniques.
Required software	Matlab, R, Python
Assignments	6 homework , 4 paper reading
Projects	1 course project
Grading	Assignments: 25 % Course project 10% Attendance 5% Midterm exams: 30 % Final exam: 30 %
Textbook(s)	[1] D.P. Bertsekas and J. N. Tsitsiklis, Introduction to Probability, 2nd Edition, Athena Scientific, 2008. [2] Mor Harchol-Balter, Performance Modeling and Design of Computer Systems: Queueing Theory in Action, Cambridge

	University Press, 2013.
Further readings	[1] Hisashi Kobayashi, Brian L. Mark, System Modeling and Analysis: Foundations of System Performance Evaluation, Prentice Hall, 2009. [2] R. Jain, The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling, Wiley- Interscience, New York, NY, April 1991. [3] Piet Van Mieghem, Performance Analysis of Communications Networks and Systems, Cambridge, 2006. [4] Kishor Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, John Wiley and Sons, New York, 2001. [5] Randolph Nelson, Probability, Stochastic Processes, and Queueing Theory: The Mathematics of Computer Performance Modeling, Springer, 1995. [6] D. Bertsekas and R. Gallager, Data Networks, 2nd Ed., Prentice Hall, 1992.