Course number and name	END 322 / System Simulation
Credits, contact hours, categorization of credits	3 credits / 42 hours / Math and Basic Sciences
Instructor or course coordinator	Erhan BOZDAĞ
Text book and other supplemental materials	• *Simulation Modeling and Analysis*, Averill M. Law, W. David Kelton, McGraw-Hill, Boston, 2000. • *Simulation With Arena*, W.D.Kelton, R.P.Sadowski, D.A.Sadowski, Mcgraw-Hill, Boston, 1998. • *Yönetimde Simülasyon Yaklaşımı*, Prof.Dr. Haluk Erkut, İrfan Yayımcılık, İstanbul, 1992.

Course information	
Content	Statistical data analysis, develop simulation models, experiment with the simulation model and to analyze experiment results.
Prerequisites	END 211/END 215 System Thinking & Analysis and END 311 Statistics
Type	Required

Course learning outcomes

Students who pass the course will:

I. Apply runs tests, sketch histogram, PP and QQ graphs, practice Chi-Square and Kolmogorov-Smirnov tests
II. Generate random numbers using random numbers for a given probability distribution
III. Develop a simulation model of a system and simulate the system by hand
IV. Develop, run, verify and validate a simulation model using ARENA
V. Design and performs experiments with simulation models
VI. Determine model features, terminating or non-terminating models, number of runs, calculate confidence interval and interpret the results
VII. Perform variance reduction techniques; control variates, common random variates, anthithetic variates.

Student outcomes	Level of contribution
SO1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	High
SO2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	Partial
SO3. An ability to communicate effectively with a range of audiences.	Not applicable
SO4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	Little
SO5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	Little
SO6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	High
SO7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Partial

Week	Topics	Learning outcome(s)
1	Introduction to the course and the term project. Definition of system, classification of systems and definition of Monte Carlo Simulation.	III
2	System analysis, description of the problem, components of system, state of system and system event	III
3	The algorithm of simulation models. The steps of a simulation study.	III, IV
4	Probability and statistics. Analysis of random input variables: Correlogram, scatter diagram, runs tests.	I
5	Analysis of random input variables: Histogram, PP and QQ chart	I
6	Analysis of random input variables: Goodness of fit tests: Chi-square test, KS test	I
7	Random numbers, random variate. Inverse transfer functions.	II
8	Composition method, acceptance-rejection method.	II
9	Output Analysis: Confidence interval. Terminating simulations.	V, VI
10	Output Analysis: Warm-up period, autocorrelation. Non-terminating simulations.	V, VI
11	Output Analysis: Examples.	IV, VI
12	Variance Reduction Techniques: Indirect measures, control variates.	VII
13	Variance Reduction Techniques: Common random numbers, antithetic random numbers.	VII
14	Validation and verification of simulation models.	III, IV