BOĞAZİÇİ UNIVERSITY
Department of Industrial Engineering

Course Syllabus

Academic year	2017-2018 / Spring
Course Code, Title, and Credit	IE 533; Systems Theory; (3+0+0) 3 credits (ECTS 7).
Prerequisites	Graduate standing or senior with GPA ≥ 2.50. Consent of the instructor.
Lecture Hours and Places	Monday 13:00 - 13:50 (5th slot); M2200 Monday 14:00 - 14:50 (6th slot); M2200 Thursday 14:00 - 14:50 (6th slot); M2171 Thursday 15:00 - 15:50 (7th slot); M2171 • From time to time, we will have some lectures in a computer laboratory, which will take place during one of the regular lecture hours. • There will be a few irregular problem session hours which will be scheduled outside of the regular lecture hours.
Lecturer	Asst. Prof. Dr. Hakan Yaşarcan
Lecturer E-mail	hakan.yasarcan@boun.edu.tr
Lecturer Office	M4084; Engineering Faculty Building; 4th floor.
L. Office Phone	+ 90 212 359 4629
L. Office Hours	To be announced.
Teaching Asst.	Nefel Tellioğlu, B.Sc.
T.A. E-mail	nefel.tellioglu@boun.edu.tr
T.A. Office	SESDYN Laboratory; Engineering Faculty Building; 3rd floor.
T.A. Office Phone	+ 90 212 359 73 43
T.A. Office Hours	To be announced.

Course Objectives	This is a course on the philosophy, science, and tools of systems theory (ST). Throughout the semester, various mathematical and quasi-mathematical techniques used in analyzing models of complex dynamic systems will be introduced. Example *complex dynamic feedback models* from socio-economic, managerial, biological, and physical systems will be discussed. Students will also be required to learn a contemporary system dynamics (SD) simulation software such as Vensim, Stella, or Powersim because a simulation software is a must in analyzing medium and large scale models.
Text Book	There will not be a strictly followed text book in this course. Lecture notes are essential.
References	• *Principles of Systems*; Jay W. Forrester; Wright-Allen Press; 1971. (Now published by Pegasus) • *Industrial Dynamics*; Jay W. Forrester; MIT Press; 1961. (Now published by Pegasus) • *System Dynamics: Systemic Feedback Modeling for Policy Analysis*; Yaman Barlas; in *Knowledge for Sustainable Development: An Insight into the Encyclopedia of Life Support Systems*; UNESCO Publishing – Eolss Publishers; 2002; pp. 1131-1175. • *Thinking in Systems: A Primer*; Donella H. Meadows; edited by Diana Wright; Chelsea Green; 2008. • *Business Dynamics: Systems Thinking and Modeling for a Complex World*; John D. Sterman; McGraw Hill; 2000. • *General System Theory: Foundations, Development, Applications*; Ludwig Von Bertalanffy; George Braziller; 1969. • *Nonlinear Dynamics and Chaos*; Steven H. Strogatz; Addison-Wesley; 1994. • *Feedback, Delays and Non-linearities in Decision Structures*, PhD Thesis; Hakan Yasarcan; Bogazici University; 2003. • *An Introduction to Systems Thinking*; Eds. Barry Richmond and Steve Peterson; High Performance Systems; 1996. • Any standard mathematics textbook on differential equations. • Any standard mathematics textbook including numerical integration methods such as Euler and Runge-Kutta.
Assignments	There will be several weekly homework assignments during the semester. All assignments are to be worked on individually by each student. Cooperation is positive and should be encouraged, but it must take place only at a general and conceptual level. You should submit your printed or handwritten homework to the instructor on time. No assignment is accepted after the due date.
Exams	There will be several quizzes and a midterm exam during the semester and a comprehensive final examination at the end. All examinations will be of closed-book/closed-notes type. More specific information will be provided before each exam. The instructor and the teaching assistant will not answer exam related questions of the students on the exam day and also on the day before the exam day. As an exception to this rule, the instructor may accept questions during the lecture hours that may be scheduled on one of these days.
Attendance and Participation	The topic is new to the students and each lecture will depend on the previous lectures. Absenteeism may result in total failure and, therefore, should be avoided. Moreover, students are expected to actively participate in in-class discussions. Therefore, student attendance is crucial.

Course Evaluation	Score 1 = (0.10×Quiz Average + 0.15×Assignment Average + 0.35×Midterm Exam Grade) / 0.60 Score 1 values will be used to rank students. Students who get reasonably high Score 1 values will earn the right to take the final exam. Students who get low Score 1 values will not earn the right to take the final exam and will automatically receive F from this course. Score 2 = (0.10×Quiz Average + 0.15×Assignment Average + 0.35×Midterm Exam Grade + 0.40×Final Exam Grade) Score 2 values will be used to rank students who receive the final exam. Students who get reasonably high Score 2 values will manage to earn a passing letter grade such as AA, BA, BB, CB, or CC. Students who get low Score 2 values will receive F.
Course Outline	**WEEK 1 (05.02.2018 Monday and 08.02.2018 Thursday)** > Course Organization and Overview > Systems, Models, and Dynamics > Purpose of Modeling > Steps of System Dynamics Methodology **WEEK 2 (12.02.2018 Monday and 15.02.2018 Thursday)** > Systems Theory and Systems Modeling > Different Ways of Doing Science > Mathematical Models of Dynamic Systems and Simulation > Simulation Time Step (DT) > Modeling Objects Used in System Dynamics > Classification of Differential Equations **WEEK 3 (19.02.2018 Monday and 22.02.2018 Thursday)** > First Order Linear Models > The Main Elements of Dynamic Complexity > Second Order Linear Models **WEEK 4 (26.02.2018 Monday and 01.03.2018 Thursday)** > Second Order Linear Models (continued) > Linear Systems Theory **WEEK 5 (05.03.2018 Monday and 08.03.2018 Thursday)** > Quiz 1 (in class) > Quiz 2 (lab. quiz) > Linear Systems Theory (continued) **WEEK 6 (12.03.2018 Monday and 15.03.2018 Thursday)** > Fundamental Modes of Dynamic Behavior > Introduction to Equilibrium and Stability Analysis (The Simple Non-linear Model Re-visited) > Quiz 3 (in class) > The Transparency of System Dynamics Models (A Simple Non-linear Model) **WEEK 7 (19.03.2018 Monday and 22.03.2018 Thursday)** > Equilibrium and Stability Analysis > Introduction to Phase Plane Analysis > General Methodology for Autonomous Models > Types of Equilibrium Points **WEEK 8 (26.03.2018 Monday and 29.03.2018 Thursday)** > Equilibrium and Stability Analysis for Nonlinear Models (single state variable) > Linearization around Equilibrium Points > Quiz 4 (in class) > Quiz 5 (lab. quiz)

Course Outline (continued)	**WEEK 9 (02.04.2018 Monday and 05.04.2018 Thursday)** > Equilibrium and Stability Analysis for Nonlinear Models (multiple state variables) > Linearization around Equilibrium Points > Phase Plane Analysis **WEEK 10 (09.04.2018 Monday and 12.04.2018 Thursday)** > Equilibrium and Stability Analysis for Nonlinear Models (continued) (multiple state variables) > MIDTERM EXAM **WEEK 11 (16.04.2018 Monday - 20.04.2018 Friday)** Spring Break **WEEK 12 (26.04.2018 Thursday)** > Flows on the Circle > Centers versus Limit Cycles > Period of Oscillations > Basic Bifurcations in Continuous Time **WEEK 13 (30.04.2018 Monday and 03.05.2018 Thursday)** > Difference Equations > Dynamics of a Simple First Order Discrete Time Model > Bifurcations in Discrete Time > Period-n Oscillations and Chaos **WEEK 14 (07.05.2018 Monday and 10.05.2018 Thursday)** > Solution of First and Second Order Discrete Time Models (Difference Equations) > Stability Analysis for Discrete Time Models (11.05.2018 Friday; the last day of classes)

Opposite of "succeeding" is not "failing", it is "giving up" or "not even trying". Accordingly, our failures are the steppingstones in achieving success.

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WE WISH YOU ALL A NICE AND SUCCESSFUL SEMESTER!