University of Tehran
School of Industrial and Systems Engineering

Course:	**8101018 – System Dynamics (1)**		
Course type:	Mandatory/Elective	IE – SE – ES/OR*	Credit: 3
Level:	Graduate		
Co-requisite(s):	-		
Prerequisite(s):	Differential Equations, Systems Analysis		
Prerequisite by topic:	-		
Reference(s):	[1] J. D. Sterman, ***Business Dynamics***, McGraw Hill, 2000. [2] R. Shone, ***Economic Dynamics***, PH, 2002.		
Coordinator:	H. Shakouri G., Associate Professor, School of ISE		
Goals:	The course provides systems engineering graduate students with the required conceptual background to understand socio-economic dynamic systems behavior and modeling techniques by means of differential equations. Students will engage various analysis methods that can describe dynamic behaviors of systems including nonlinear relationships. They can find general perception of the interconnections between system components and understand how they affect each other, so that can implement causal loops and stock-flow diagrams.		
Topics:	Chapter 1. **Introduction** (Introduction to system thinking, causality, and feedback) Chapter 2. **Examples of Dynamic Modeling and Applications** Chapter 3. **Modeling Techniques and Basic Math** (Introducing concepts of modeling and required basic math) Chapter 4. **Linear Systems** (Analysis of linear dynamic systems, solution methods in for linear systems, and their behaviors) Chapter 5. **Nonlinear Systems** (Differences, chaotic behaviors, limit cycles, equilibriums) Chapter 6. **Applications in Social and Economic Systems** (mathematical models for social system modeling: population and growth models, macro/micro economic systems: business		

	cycles, logistic growth models, Polya structure for competition models, etc.) Chapter 7. **Stability and Instability** (Stable/unstable Equilibrium points, phase plane method, isoclines, trajectories, path dependence) Chapter 8. **Delays and Smoothing** (Mathematics of modeling delay, weighted averages, and smoothing filters, Nonlinear delays, cohorts and co-flows) Chapter 9. **Introduction to Identification and Model Validation** (Quantification, data gathering, calibration, regression, test methods, scenario/sensitivity analyses, validation of dynamic models)
Computer usage:	MATLAB, EXCEL, VENSIM
Assignments:	6 – 10 homework assignments
Projects:	Understanding a concurrent socio-economic system problem, analysis and proposing a dynamic model to run and find practical solution by scenario analysis
Grading:	Assignments: 10 % Midterm exams: 10 % Final exam: 40 % Course Project: 40 %
Further readings:	[1] Stephanie Albin, Jay W. Forrester, Building a System Dynamics Model (1997), Massachusetts Institute of Technology.
Date:	August 19, 2011

*IE: Industrial Engineering SE: Systems Engineering ES: Energy Systems