**ABET Course Syllabus – CS3660**

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| **Code** | CS3660 | **Credits** | 3 |
| **Title** | Complex Social and Economic Systems | **Coordinator** | Mohammad Pourhomayoun |

**Course Information**

1. **Catalog Description:** Computational approaches to modeling, simulation, and analysis of complex social and economic systems: statistics (frequentist and Bayesian); game theory, agent-based and stocks and flows modeling; networks; data science. Graded ABC/NC.
2. **Prerequisites:** CS2148; Prerequisite/Co-requisite: CS3112.
3. **Contact Hours:** Lecture 3 hours.
4. **Required/Elective:** This course is an elective in the BS program.

**Textbook**

* De Marchi, Scott. *Computational and Mathematical Modeling in the Social Sciences.* Cambridge University Press, 2005.
* Mitchell, Melanie, *Introduction to Complexity* (MOOC). Santa Fe Institute, 2014.

**Course Goals**

The Student Learning Outcomes that are addressed by the course are:

* *SLO1. Students will be able to apply concepts and techniques from computing and mathematics to both theoretical and practical problems.*
* *SLO2. Students will be able to demonstrate fluency in at least one programming language and acquaintance with at least three more.*
* *SLO3.* *Students will have a strong foundation in the design, analysis, and application of many types of algorithms.*
* *SLO5. Students will have the training to analyze problems and identify and define the computing requirements appropriate to their solutions.*
* *SLO7. Students will be able to communicate effectively orally and in writing.*
* *SLO9. Students will have the ability to analyze the local and global impact of computing on individuals and society.*

Other outcomes of instruction:

At the end of the course, students are able to

* Understand the kinds of questions examined in the fields of complex systems, especially those related to economics and the social sciences and how those questions are approached by experts in the field.
* Integrate the fundamental concepts of the following areas into their skill set and use these concepts and principles in software development and in particular for building software relevant to economics and the social sciences.
	+ Statistics and statistical analysis (frequentist, Bayesian, power law)
	+ Game theory
	+ Agent-based and stocks-and-flows modeling
	+ Network analysis, especially as applied to social networks
	+ Evolutionary processes
	+ Fractals and chaos theory

**Topics Covered**

* Part I. An introduction to complex system phenomena and in particular to the complex-system-related issues examined in the fields of economics and the social sciences. Examples selected from: segregation patterns (e.g., Schelling), the efficient market hypothesis and its critics (e.g., Lo), altruism and cooperation (e.g., de Waal), the commons across cultures (e.g., Ostrom), emergence and emergent organizations, the ubiquity of power law distributions (e.g., Zipf), fractal structures and organizations (Mandelbrot), culture and evolutionary games (such as the Ultimatum Game), chaotic processes (e.g., Lorenz), economic equality and inequality and the Gini coefficient, scaling laws (e.g., West), behavioral economics (e.g., Kahneman), and others.
* Part II. Computational theories, tools, and techniques for the modeling, simulation, and analysis of complex systems.

A. Introduction to statistics (frequentist, Bayesian, power law) and computational tools for statistical analysis

B. Introduction to Game Theory and evolutionary game theory

C. Introduction to Agent-based and Stocks-and-flows modeling

D. Introduction to Social Networks, network structures (e.g., small world, preferential attachment, etc.) and network analysis

E. Introduction to Fractal structures and chaos theory

F. Introduction to Evolutionary processes and meta-heuristic optimization, e.g., genetic algorithms, ant colony optimization, etc.

G. Introduction to Data Science.