ESM620 Analysis of Complex System Networks

Program and Course Code	Engineering Systems and Management Program ESM 620
Course Title	Analysis for Complex System Networks
Credit Hours	3
Instructor	Dr. Inas Khayal
Contact Information	Email: ikhayal@masdar.ac.ae Tel. 02 810 9128
Office Hours	TBA
Bulletin Course Description	This course is intended to present Complex Networks from an Engineering Systems point of view building on the System Architecture course. It provides the tools to describe and analyze engineering, social, organizational, biological, and communication, networks. A large portion of the course is dedicated to quantitative analyses of networks and tools for their visualization. The class will also review the latest research publications in engineering systems network applications. Particular emphasis will be given to the engineering system grand challenges of today: health, social-communication, power, transportation, and water.
Pre-requisites	ESM501 or equivalent
Co-requisites	None, but ESM 510 is recommended.
Course Objectives (Learning Outcomes of the Course)	On completion of this course, students will be able to: • Understand, recognize and discuss complex networks around us • Describe and analyze complex networks • Understand different visualization tools for large & complex network data • Analyze and critique the latest journal publications of networks for multiple network applications • Develop excellent team communication skills • Develop excellent written and oral communication skills

Week	Course Topics and Contents
1	Course Introduction What are networks, where are they and why are they important?
2	Types of Networks: Technological, Social, Biological, etc. Introduction to graphs, networks and Design System Matrix's
3	Mathematics of Networks
4	Measure and Metrics
5	Network Models - Random Networks, Small World, and Scale Free Networks
6	Network Visualization Tools I
7	Mid-term Exam
8	*Mid-Term Break*
9	Network Visualization Tools II
10	Advanced Network Modeling Techniques
11	Application I: Health Networks: Biological Networks Healthcare Networks
12	Application I: Health Networks: Social Networks
13	Application II: Organizational Structures
14	Application III: Power Grid & Water Networks
15	Application IV: Transportation & Social Networks
16	Project Final Presentations

Relationship of course objectives to IDDP Program outcomes	
Program Outcome	Demonstrate appropriate depth and breadth of knowledge that is at the frontier of their disciplines
Program Outcome	Use skills of interdisciplinary scholarship and research to integrate multiple perspectives
Program Outcome	Understand and value diverse approaches to solving critical problems in research and to creating new knowledge judged by international standards
Program Outcome	Work effectively in a multidisciplinary collaborative environment using highly developed cognitive and creative expert skills and intellectual independence
Program Outcome	Communicate effectively, in written and oral forms, their research results and/or critique highly complex and diverse matters to diverse audiences
Program Outcome	Use self-development for personal and professional improvement in their field and contribute to its future advancement

Out-of-class assignments	
Homework	Out-of-class assignments: • Two homework assignments • Group Research Paper Essay • Project Proposal • Project Final Paper

Course Grading	
Class Participation and Discussion	10%
Assignments	20%
Mid-Term Exam	20%
Group Research Paper Discussion	10%
Group Research Paper Essay	10%
Project Proposal	5%
Project Final Paper	15%
Project Presentation	10%
Total	100%

Class/Laboratory schedule and Methodology	
Class	The class meets 15 weeks, 2 lectures per week, 75 minutes each.
Laboratory	At least one visualization session will be held in the Lab.
Teaching and learning methodologies	Lectures, hands-on-lab examples, and roundtable paper discussions. Students will be exposed to and master material by attending class; performing the homework assignments, in- and out-of-class lab assignments, leading roundtable paper discussions and presentations along with a written essay and final project. Students will work both in groups and individually.

Course Materials	
Textbooks	Main Textbook: Newman, MEJ. *Networks An Introduction*. Oxford University Press. 2010. Supporting Chapters from: Eppinger & Browning. Design Structure Matrix Methods & Applications Research Application Papers will be identified at the beginning of the semester.
Recommended Readings	Course reader assembling different materials: book chapters and journal articles.
Instructional material and resources	Masdar Internal Teaching website will be utilized.