Spring 2021

CE 671-102: Performance and Risk Analysis of Infrastructure Systems

Fadi Karaa

Dr. Fadi Karaa Spring, 2021

CE 671-102: Critical Infrastructure I
Performance and Risk Analysis of Infrastructure Systems

Class Hours

Wed 6:00PM-8:50 PM Synchronous On-Line (First Day of Class Jan 20, 2021)

Office Hours (On-line; Office at Colton 274 for special circumstances)

Wed 4:30 PM- 6:00 PM On-Line or by e-mail or appointment
at (973) 642-4198 or karaa@njit.edu

Canvas:
https://njit.instructure.com/courses/15764

Prerequisites: (MATH 225 –Survey of Prob. & Stats. Or equivalent)

Instructor: Fadi A. Karaa, PhD

REQUIRED TEXT

Martland, Carl, "Toward More Sustainable Infrastructure", 2012, John Wiley & Sons, Incorporated, ISBN:9780470448762. This textbook is referred to in syllabus as TMSI.

OTHER REFERENCES

Hudson, W. Ronald, Hass, R. and Uddin, W., *Infrastructure Management, Design, Construction, Maintenance, Rehabilitation, Renovation, McGraw Hill, 1997, out of print, ISBN 0-07-030895-0.* This textbook is referred to as IM. Chapters from IM are listed as further reading background, and are optional.

Grigg, Neil S., *Water, Wastewater and Stormwater Infrastructure Management,* Lewis Publishers, CRC Press, www.crpress.com, 2003, ISBN number 1-56670-573-8.

Other files are assigned electronically as supplemental readings and will be posted on Canvas or emailed in some cases to class participants. These are denoted in course outline as Efiles.

COURSE DESCRIPTION:
This course presents a Comprehensive systems approach to infrastructure asset management across areas of public and private infrastructure. Topics include the framework of integrated asset management illustrated in transportation, water and wastewater systems, the economic evaluation of infrastructure options, using life cycle cost analysis (LCCA) and cost-benefit analysis (CBA). The elements of performance measurement and modeling, including condition assessment and information management, failure and impact analysis are covered. Decision and risk analysis are covered to enable students to develop a holistic economic, performance and risk analysis approach to infrastructure management illustrated in a term project. Infrastructure financing options and private-public partnerships are presented and discussed

LEARNING OUTCOMES
This course covers the analytical issues related to the modern approach of infrastructure management. Using the methodologies covered, you should be able to:

- Analyze potential infrastructure projects or alternative configurations.
- Perform a professional comparative economic/financial analysis of infrastructure projects
- Understand and apply the concepts of life-cycle analysis and their particular relevance to infrastructure maintenance, rehabilitation and reconstruction.
- Understand the components of modern Asset Management, condition assessment and performance measurement.
- Understand the concepts and high-level architecture of IT-based maintenance management systems, and the multi-step managerial approach to maintenance management.
- Develop an understanding of the range of techniques for project evaluation, prioritization and optimization of work programs
- Understand the methodology of risk analysis and its application to infrastructure problems.
- Identify the components and process flow of a comprehensive Infrastructure Assessment study applied to a wastewater network.

COURSE OUTLINE (Subject to updating throughout semester)

Week	Date	Textbook/Reading	Assignment	Topics
1	20-Jan	TMSI Ch. 1, Efiles, National Council on Public Works Improvement	Assignment 1 (2 week): Case on Infrastructure Development Strategy, Infrastructure Links to Economy – Part 1	Introduction to Infrastructure Mgmt, Asset Management, Project Evaluation, Infrastructure Impact Hierarchy in Development
2	27-Jan	Efiles, TMSI Ch. 4, Role of Infrastructure on Economic Recovery, Growth and Trade		Infrastructure Links to the Economy - Part 2; Public Perspective: Economic, Environmental & Social Concerns in Project Evaluation
3	3-Feb	TMSI Ch.7, Efiles	Assignment 2 (2 week): Financial Analysis/Project Evaluation	Annuity Analysis; Future and Present Value Analysis; Financial Analysis of Projects
4	10-Feb	Efiles (On-line)		Capital Budgeting; Evaluation Techniques, Cost-Benefit Analysis (CBA) Primer; LCCA
5	17-Feb	EFiles, BCA, LCCA Primers, DOT examples/manuals,	Assignment 3 (2 week): CBA, LCCA, Project and Capital Budgeting Financial Models	Benefit-Cost Analysis (BCA) and Life Cycle Cost Analysis Methods;
6	24-Feb	Efile, TMSI Ch. 9 and 10,		NPV and IRR Methods with Depreciation and Taxation Effects; Taxation

				and Depreciation; Capital Rationing, Project Prioritization
7	3-Mar	TMSI Ch. 3 ,	Assignment 4: Chapter 3, Consumer Surplus, Elasticity of Demand Assignment, Consumer and Producer Surplus	Economic Analysis of Infrastructure Projects (Pricing, consumer Surplus, economies of scale, etc.)
8	10-Mar	Transportation Asset Management E-Files		Transportation Asset Management; New Guide; Advances State of the Practice
	14-21 Mar	SPRING RECESS		
9	24-Mar	Mid-Term Exam	Abstract for Term project Due	
10	31-Mar	TMSI Ch. 11.1 and 11.2, Efiles TMSI, Ch. 2, System Performance; Efile, "Performance of Water Distribution Networks", Karaa and Marks	Assignment 5: Infrastructure Master Planning Analysis Case Design of Performance Model;	Infrastructure Planning, Maintenance Mgmt. Systems/ Condition Assessment Performance Models, Measurement, Deterioration Curves
11	7-Apr	TMSI Ch. 11.3, 11.4, Efiles Paper Handouts, DA E-File	Decision and Risk Analysis Modeling Assignment 6 (2 weeks)	Dealing with Uncertainty, Infrastructure Decision/Risk Analysis, Project Teams Integration Planning Meeting
12	14- Apr	E-Files, TMSI Ch. 13, Handout on Bayesian Methods, and Value of Information Term Project Final Planning		Decision and Risk Analysis Modeling, Bayesian Updating (ctd.)
13	21-Apr	Papers (wastewater system IM, optimal replacement time concepts, E-Files)		Wastewater Infrastructure Management and Optimal replacement Time Concepts; Integrated IMS Case Infiltration and Inflow, Program Prioritization
14	28-Apr	Papers (water distribution budgeting models, Sewer I&I control, E-Files)		Optimization Models for Infrastructure Portfolio Management and Advanced Computerized Condition Assessment Techniques
15	5-May	Team Final Presentations		Presentation Term Papers

Final Exam date (May 7 to 13) may be used for continuation of class presentations if needed.

NJIT Honor Code: the NJIT Honor Code will be upheld; any violations will be brought to the immediate attention of the Dean of Students.

GRADING POLICY:

In order to cover a broad cross-section of subjects, Students will be asked to write a paper and present their key points during a 10-15 minute presentation. This term paper/presentation will account for 35% of the overall grade.

The overall term grade will be based on the following elements:

Paper/Presentation: 35% (Term Paper Expectations and Grading model will be provided in detailed document)
Homework and Class Participation: 35%
Mid-Term: 30%

Note: March 17 Class does not meet as it is Spring recess Week.

(Note: THE WEIGHTS of GRADES may be adjusted).

CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:
- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our Program Educational Objectives are reflected in the achievements of our recent alumni:
1. Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward safe, practical, sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.
2. Professional Growth: Alumni will advance their technical and interpersonal skills through professional growth and development, activities such a graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.
3. Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:
1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.
2. 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.
3. an ability to communicate effectively with a range of audiences.
4. 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.

5. 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.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Spring 2021 Academic Calendar

January	18	Monday	Martin Luther King, Jr. Day
January	19	Tuesday	First Day of Classes
January	23	Saturday	Saturday Classes Begin
January	25	Monday	Last Day to Add/Drop a Class
January	25	Monday	Last Day for 100% Refund, Full or Partial Withdrawal
January	26	Tuesday	W Grades Posted for Course Withdrawals
February	2	Tuesday	Last Day for 90% Refund, Full or Partial Withdrawal, No Refund for Partial Withdrawal after this date
February	15	Monday	Last Day for 50% Refund, Full Withdrawal
March	8	Monday	Last Day for 25% Refund, Full Withdrawal
March	14	Sunday	Spring Recess Begins - No Classes Scheduled - University Open
March	21	Sunday	Spring Recess Ends
April	2	Friday	Good Friday - No Classes Scheduled - University Closed
April	5	Monday	Last Day to Withdraw

May	4	Tuesday	Friday Classes Meet
May	4	Tuesday	Last Day of Classes
May	5	Wednesday	Reading Day 1
May	6	Thursday	Reading Day 2
May	7	Friday	Final Exams Begin
May	13	Thursday	Final Exams End
May	15	Saturday	Final Grades Due
TBA			Commencement