Risk and Decision Analysis
&
Engineering Systems Analysis for Design

Course Introduction

IDS.332J and IDS.333

Welcome!

- It's a pleasure to be with you – in person
- We will be covering much new material
- I look forward to learning with you
- Hope to make some long-term friends

GOOD MORNING!

BONJOUR !

¡BUENOS DIAS!

GUTEN MORGEN !

SALAAM ALEIKUM !

O HAYO GOZAIMASU !

SELAMAT DATANG !

ΚΑΛΗ ΜΕΡΑ !

NI HAO MA !

NAMASTE !

SHALOM !

BOM DIA !

Today's class has 4 parts

1. Brief Course Introduction
2. Review of Pre-Read Responses
3. Discussion of Paradigm Shift
4. Example Project

IDS.333J / IDS.332

- You are at opening of 2 subjects!
- IDS.332J (also 1.146, 16.861) : *Engineering Systems Analysis for Design* 12 units
- IDS.333: *Risk and Decision Analysis* 6 units (at pace or 12 hours/week or ½ semester)
  - Methods, followed by applications in either
  - IDS.332 for those that continue in fall
  - IDS.330 6 unit Spring course *Real Options for Product and System Design*
- Which should you choose (if any)?

IDS.332 / IDS.333, IDS.330 Choice

- Many students choose either
  - Combination of 6 unit Fall and Spring courses
  - Or 6 unit Fall course alone
- Because
  - Possibly not yet ready for a deep dive into an application project
  - They'll appreciate that course ends in October and lightens end of semester heavier loads
  - In Spring they will be ready for deep dive application, to either thesis or other project
- See Canvas sites for full details for each

IDS.333 / IDS.332 / IDS.330 Choice

- **IDS.332: Engineering Systems Analysis for Design, 12 unit, Full semester course**
- The second half of the semester will be project oriented. It will combine lectures, seminar discussions, and personal coaching on project
- Restricted to students who
  - Can develop or have a suitable personal project
  - We explore this with discussion of “Initial Project Status” form

Content: First half of Semester

- Main Objectives:
  1. To increase your awareness and appreciation for *WHY uncertainty matters* in engineering design, Being Proactive better than being Passive
  2. To give you tools to *analyze effect of uncertainty on performance of design,*
  3. To help you appreciate *how to choose best tool for your problem*, and
  4. To use the tools to *design flexible strategies* that will maximize overall expected performance

Content: Second Half of Semester

- Overall objective:
  - To give you confidence in practical application of course material to engineering design
- Topics
  - Drivers for Flexibility
  - Decision Rules
  - Real Options Theory
  - Multidimensional Choice
  - Case Examples
  - Creating a Strategy: Choice and Plan
- Project: Preparation of a Design or a Plan with Flexibility based on analysis of alternative options

Introduction of Teachers

- Richard de Neufville
  - Prof. of Engineering Systems, MIT Institute for Data, Systems, and Society (IDSS)
  - Civil Engineer by training, specialty in “airports”
  - International practice “every inhabited continent”
  - Sabbaticals: England, France, Portugal, Japan, Australia… and California
  - Rows and will participate in Head of Charles

Website: ardent.mit.edu

Introduction of Teachers

Aparna Kulkarni, Teaching Assistant

- Fellow, MIT System Design & Management
- Was Systems Engineer at Honeywell
- Worked 8+ years in Industrial, particularly Building, Automation
- Current interests: Innovations in energy industry, exploring System of Systems with emphasis on Smart Cities using platform solutions
- Academic background: Instrumentation and Controls Engineering

Logic of the Course

- Engineering Systems exist in Uncertainty
  - Technical – New Developments
  - Economy – Boom, Crisis, Prices, Competition
  - Social – New Regulations, Political Changes
- Engineering Systems Need to Adapt
  - Take advantage of Opportunities
  - Avoid Hazards, Risks
- Flexibility is an Essential Part of Design
  - How do we identify, choose, and implement flexibility?
- Course shows ***how*** to Determine Answers

New Material

- New Approach to Engineering Design
  - Recognizes Uncertainty and Use of Flexibility, thus Changes Engineering Design Process
- Revolutionary possibilities
  - Explicit consideration of flexibility easily increases expected performance 30% !
- Related to “Real Options”, but different
- Procedures developed to fit engineering realities
  - Little historical data ; Rapid Procedures needed
- Develops coherent road-map for strategic design

Objectives of First half of Semester

1. Conceptual framework for thinking about designing/decision-making under uncertainty.
2. Introduce useful tools for helping you think and do analysis in these situations.

Course will present 4 elements:

- Uncertainty
- Value over Time
- Simulation over Spreadsheet
- Decision Analysis, Value of Information

Prerequisites

- Syllabus assumes:
  - comfort with basic calculus, probability, statistics
  - familiarity with some advanced concepts of Excel used in course
  - Presentation of necessary Excel material built into course

Courses “Flipped”; on Canvas

- In general “lecture material” distributed on web in advance, and discussed in-person classes
- Students review “lecture material” before class, and respond to it via “Pre-Read” forms
- Pre-Read responses form basis for in-person discussion of questions, and lead to further clarifications and extensions
- Pre-Read assignments are not graded but each earns full points for participation
- Canvas is course management system

Questions?

THANK YOU FOR YOUR ATTENTION

NOW AVAILABLE FOR DISCUSSION

IDS.333 Risk and Decision Analysis
Fall 2021