UNIVERSITY OF MARYLAND

College Park Campus

Department of Civil and Environmental Engineering

ENCE 621 - Uncertainty Modeling and Analysis (3)

COURSE OBJECTIVES

The student will learn the basics of uncertainty modeling and analysis for engineering systems including basic uncertainty modeling concepts, uncertainty types and modeling methods. Engineering applications and case studies will be used to demonstrate introduced concepts.

CATALOG DESCRIPTION

Definition of engineering systems, knowledge levels using information science concepts as applied to engineering systems, sources and types of knowledge and ignorance, uncertainty sources and types for engineering systems, probability models, statistical models, fuzziness, fuzzy sets, fuzzy logic, fuzzy arithmetic, imprecise probabilities, evidence methods, uncertainty measures, uncertainty management, uncertainty reduction, applications of these analytical methods to engineering systems and in decision making.

RECOMMENDED PREPARATION

Fundamentals of probability theory and an appreciation for uncertainty in engineering systems.

INSTRUCTOR

Bilal M. Ayyub, PhD, PE, Professor; ba@umd.edu; Telephone 301-405-1956; Fax – x 2585;
Office Hours: TBD and by appointment, Room 0305, Eng. Classroom Bldg.

TEXTBOOK

B. M. Ayyub and G. L. Klir. *Uncertainty Modeling and Analysis for Engineering and the Sciences*, CRC Press, FL, 2006.

GRADING

Homework and project: 50%
Exams: 50%

COURSE OUTLINE

Chapter 1. Systems, Knowledge, and Ignorance

Data Abundance and Uncertainty, Systems Framework, Knowledge, Ignorance, and From Data to Knowledge for Decision Making

Chapter 2. Encoding Data and Expressing Information

Identification and Classification of Uncertainty Modeling Theories, Crisp Sets and Operations, Fuzzy Sets and Operations, Fuzzy Measures and Operations, Rough Sets and Operations, and Grey Systems and Operations

Chapter 3. Uncertainty and Information Synthesis

Goal-Driven Synthesis, Measure Theory, Monotone Measures, Evidence Theory, Fuzzy Measures and Fuzzy Integrals, Probability Theory, Bayesian Probabilities, Interval Probabilities, Interval Cumulative Distribution Functions, Probability Bounds, Possibility Theory

Chapter 4. Uncertainty Measures

Uncertainty Measures: Definition and Types, Nonspecificity Measures, Entropy-like Measures, Fuzziness Measure, Other Measures, and Application: Combining Expert Opinions

Chapter 5. Uncertainty-Based Criteria and Knowledge Construction
Construction of Knowledge, Minimum Uncertainty Criterion, Maximum Uncertainty Criterion, Uncertainty Invariance Criterion, Demonstrative Examples of Aggregating Expert Opinions, Closed-World Versus Open-World Assumption
Chapter 6. Uncertainty Propagation for Systems
A Fundamental Input-Output System, Interval Parameters, An Interval Power and a Set of Intervals, Sets of Intervals,. An Interval Power and a Set of Interval Powers
Chapter 7. Expert Opinions and Elicitation methods
Classification of Issues, Study Levels, Experts, and Process Outcomes, Process Definition, Need Identification for Expert-Opinion Elicitation, Selection of Study Level and Study Leader, Selection of Peer Reviewers and Experts, Identification, Selection and Development of Technical Issues, Elicitation of Opinions, Documentation and Communication
Chapter 8. Visualization of Uncertainty
Point and Global Visualization, Use of Colors, Financial Visualization, Icons, Ontology and Lexicon, From Data to Epiphanies

HOMEWORK ASSIGNMENTS
Professional presentation of homework assignments is required. Professional presentation consists of neat and organized solution of problems on one side of 8.5"x11" papers with the students name clearly marked on each page. Homework will be assigned at the conclusion of each chapter, and are due one week after they are assigned.

PROJECT
Each student or small team of students (up to 2 people) is required to prepare a course project on an uncertainty related topic or technology. Topics include extensions to current theory, literature reviews with illustrative examples, applications to engineering problems, software tool development, and simple demonstrative experiments. In the past, many students found success by applying one or more of the topics covered to their current research. A recommended format for the final project report is as follows:

- Title Page
- Executive Summary and Table of Contents
- Objectives and scope
- Historical development
- Methodology summary
- Applications
- New concepts and directions
- Conclusions
- References and Appendices

Professional presentation of the project report is required that should consist of neat and organized solutions on one side of 8.5"x11" papers. Computer-generated plots and printouts are required for all sample, and summary calculations.

EXAMS: All students must take all exams including the final exam. Only extenuating circumstances will be accepted as excuse for missing an exam. Health related excuses require medical reports and the signature of a physician that provided treatment. Academic integrity is an important foundation and required as defined at http://www.inform.umd.edu/jpo/. UMD course-related policies: http://www.ugst.umd.edu/courserelatedpolicies.html