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| **d98059aa-60fd-451e-8e04-8810032eee2c** | **Engineering Risk and Reliability** |

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| Professor Wei-Chau Xie | Email: xie@uwaterloo.ca |

This course is intended to give a broad treatment of the subject of engineering decision, risk, and reliability. Emphasis is given to

1. the modelling of engineering problems and evaluation of systems performance under conditions of uncertainty;
2. systematic development of design criteria, explicitly taking into account the significance of uncertainty;
3. the logical framework for risk assessment and risk-benefit trade-off analysis relative to decision making.

The necessary mathematical concepts are developed in the context of engineering problems and through illustrations of probabilistic modelling of physical situations and phenomena. Applications in civil engineering, especially in geotechnical engineering, are emphasized.

# **\*Introduction and Review of Applied Probability Concepts**

# **Bayesian Statistical Concepts (2 hours)**

Systematic updating of engineering information

# **Engineering Decision Analysis (2 hours)**

Decision tree and criteria, value of information. Applications:

* \*water resources planning
* \*pollution management
* \*transportation systems planning
* earth dam site selection

# **Stochastic Models and Applications (2 hours)**

Markov chains: state probabilities, mean time between states. Applications: soil stratification, stream pollution, and quality control program.

\*Queuing models: queue length probabilities, waiting time distribution. Applications: construction process, transportation system

\*Availability models: optimal inspection and repair programs

# **Analysis of Complex Probability Problems Using Monte Carlo Simulation**

#  **(2 hours)**

# Applications:

* optimal reservoir design
* \*air traffic in an airport

# **Reliability and Reliability-Based Design (4 hours)**

Analysis and assessment of reliability, second-moment formulation, probability-based design, and second-moment criteria. Applications:

* \*structural element
* foundation
* hydraulic subsystems

# **System Reliability (4 hours)**

Multiple failure modes, probability bounds, redundant and non-redundant systems, fault tree and event tree analysis. Applications:

* buildings
* \*transmission lines
* hydraulic systems
* \*waste disposal systems

\* These topics are presented in the notes but may not be covered in lectures due to time limitations.

**Text: Wei-Chau Xie, *Engineering Risk and Reliability* Notes.**

**Main References:**

1. **H-S. Ang and W.H. Tang, 1984, *Probability Concepts in Engineering Planning and Design,* Volume II *— Decision, Risk, and Reliability*, John Wiley *&* Sons, Inc.**
2. H-S. Ang and W.H. Tang, 1975, *Probability Concepts in Engineering Planning and Design,* Volume I *— Basic Principles*, John Wiley *&* Sons, Inc.

**Instructor: Professor Wei-Chau Xie**

 Department of Civil and Environmental Engineering

 University of Waterloo, Canada

Wei-Chau Xie is a Professor in the Department of Civil and Environmental Engineering at the University of Waterloo, Canada. He is the author of *Dynamic Stability of Structures, Differential Equations for Engineers,* and *Seismic Risk of Nuclear Power Plants,* all of which were published by the Cambridge University Press. He has published numerous journal articles on dynamic stability, structural dynamics and random vibration, nonlinear dynamics and stochastic mechanics, reliability and safety analysis of engineering systems, and seismic analysis and design of engineering structures. He received the Teaching Excellence Award in 2001 in recognition of his exemplary record of outstanding teaching, concern for students, and commitment to the development and enrichment of engineering education at Waterloo. He is the recipient of the Distinguished Teacher Award in 2007, which is the highest formal recognition given by the University of Waterloo for a superior record of continued excellence in teaching.

谢伟超 (Wei-Chau Xie) 教授是加拿大滑铁卢大学杰出教授，长期从事工程结构抗震分析和设计、结构动力学和随机振动、工程系统可靠性和安全性分析等领域的教学和科研工作，在工程结构动力稳定性、结构动力学、结构抗震分析与设计等领域享有国际声誉。