

SYDE 760: Probabilistic Design

Instructor: K. Ponnambalam (*call me "ponnu"*)

Office hours: Email me anytime for a reply and to fix an appointment, if needed; ponnu@uwaterloo.ca (**Your email subject heading should start with SYDE 760 when emailing me for course help**)

Course URL: Use Tophat (as invited) and Learn

Topics will include: introductory time series analysis and queuing theory, Markov decision processes, stochastic programming and models for optimization of large systems under uncertainty. This course will include a major project that considers a design of systems under uncertainty

Evaluation:

Assignments + Class participation (individual)	10%
Computer assignments (in class/tutorial)	20% (
Midterm Exam (in Class)	25%
Final Exam (Theory part in class)	30%
Practical Exam	15%

Practical exam is an application of one or more methods from the course to solve a given problem with computational methods and tools (Octave, or Matlab) learnt in the class for an application

All assignments, Octave or any computer code must be submitted in softcopies.

General Overview of the Course: (More details in Schedule; see in Tophat)

Introduction to SYDE 760 (First class – 1 week)

- General formulation of an optimization problem - Designing systems under uncertainty

A. Review of Optimization (2 Weeks)

- Dynamic Programming^[L]_[SEP]- Unconstrained Optimization^[L]_[SEP]- Constrained Optimization^[L]_[SEP]- Expanded Lagrangian Function (EFL) Optimization^[L]_[SEP]- Normalized Expanded Lagrangian Function (NEFL) Optimization

B. Review of Probability Theory and Probability Estimation (2 Weeks)

- Random Variables and their Moments^[L]_[SEP]
- Functions of Random Variables and their Moments (First Order Second Moment^[L]_[SEP]method)^[L]_[SEP]
- Chebyshev's inequality^[L]_[SEP]
- Monte-Carlo Simulation of random variables^[L]_[SEP]
- Markov Chains^[L]_[SEP]

C . Robust Design (2 Weeks)^[L]_[SEP]

D. Stochastic Programming and Chance-Constrained Programming (2 Weeks)

E. Stochastic Dynamic Programming (1 Weeks)^[L]_[SEP]Final Examination (1 Week)^[L]_[SEP]Practical Examination (~2 Weeks)^[L]_[SEP]

The Tophat book of mine is sufficient that presents all the above material. However, there are reference books and articles that could be used in addition if students wish to.

Section A:^[L]_[SEP]Bertsekas, D.P., Chs 1,3-4 of Nonlinear Programming, Athena Scientific, Mass., 1995 [HARD]

Section B:^[L]_[SEP]Papoulis, A., Chapters 1-7 of Probability, Random Variables, and Stochastic

Processes, 3rd Edition, McGraw-Hill Publ., 1991 [HARD]

Section C: Structural Design Optimization Considering Uncertainties: Structures & Infrastructures Book , Vol. 1, Series, Series Editor: Dan M. Frangopol Hardcover – Mar 24 2008 [HARD]

by Yannis Tsompanakis (Editor), Nikos D. Lagaros (Editor), Manolis Papadrakakis (Editor)
ISBN-10: 0415452600
ISBN-13: 978-0415452601

Hillier, F.S., and G. J. Lieberman, Chs 1-3,5 of Intro. to Stochastic Models in Ope. Res., McGraw-Hill, 1990.

Section D, and E [SEP] Hillier, F.S., and G. J. Lieberman, Chs 8,11 of Intro. to Stochastic Models in Ope. Res., McGraw-Hill, 1990.

Wagner, H.M., Ch 16 of Principles of Operations Research, 2nd Ed., 1975. Reference Textbooks:

Introduction to Stochastic Programming
Authors: John R. Birge, François Louveaux
ISBN: 978-1-4614-0236-7 (Print) 978-1-4614-0237-4 (Online)

Research Papers and Related Sections in the Course (An asterisk indicates that the author was a student of this course):

*Sadjadi S.J., and K. Ponnambalam, 1997. Advances in trust region algorithms for constrained optimization, Applied Numerical Mathematics, Vol 29., 423-443, 1999. [Section A].

*Shavezipur, M. , K. Ponnambalam, Khajepour, A., and Hashemi, S. M., 2008. Fabrication uncertainties and yield optimization in MEMS tunable capacitors, *Sensors and Actuators A: Physical*, 147, 613-622. [Sections B and C]

*Alvarez, J., K. Ponnambalam, and V. H. Quintana, 2007, Generation and transmission expansion under risk using stochastic programming, *IEEE Transactions on Power Systems*, 22 (3), 1369 – 1378. [Section D]

*Mahootchi, Masoud , K. Ponnambalam, H. Tizhoosh, 2010. Comparison of risk-based

optimization models for reservoir management, *Canadian J. of Civil Engineering*, 37, 112-124. [Sections D and E]

Academic Integrity:

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/ for more information.]

Grievance:

A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline:

A student is expected to know what constitutes academic integrity [check www.uwaterloo.ca/academicintegrity/] to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about rules for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties check Guidelines for the Assessment of Penalties, www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

Appeals:

A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

Note for Students with Disabilities:

The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.