

MGT-484

**Applied probability & stochastic processes**

Sutter Tobias

Cursus	Sem.	Type
Life Sciences Engineering	MA1, MA3	Opt.
Management of technology		Opt.
Management, Technology and Entrepreneurship minor	H	Opt.
Managmt, tech et entr.	MA1, MA3	Obl.
Systems Engineering minor	H	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Courses	2 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

This course focuses on dynamic models of random phenomena, and in particular, the most popular classes of such models: Markov chains and Markov decision processes. We will also study applications in queuing theory, finance, project management, etc.

**Content**

The following topics will tentatively be covered in the course:

**1. Discrete-time Markov chains**

- Basic definitions, transition probabilities
- Classification of states
- Stationary and limiting distributions, convergence to equilibrium
- Hitting times and absorption probabilities
- Strong Markov property, law of large numbers for Markov chains

**2. Dynamic programming and optimal control**

- Basic principles
- Linear systems and quadratic cost, Ricatti equation
- Utility functions, dynamic portfolio allocation
- Optimal stopping
- Correlated disturbances, state augmentation

**Keywords**

Markov chains, Markov decision processes, dynamic programming, optimal control

**Learning Prerequisites****Required courses**

A course in basic probability theory

**Important concepts to start the course**

Students should be familiar with basic concepts of probability theory, calculus and linear algebra.

**Learning Outcomes**

By the end of the course, the student must be able to:

- Formulate Markov chain models for dynamic uncertain phenomena.

- Formulate Markov decision process models for dynamic decision problems under uncertainty.
- Use these models to structure real decision-making situations.
- Compute relevant performance measures for Markov models.
- Develop an awareness of the manifold uses of probability theory in management science.

### Transversal skills

- Communicate effectively, being understood, including across different languages and cultures.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.

### Teaching methods

Classical formal teaching interlaced with practical exercises.

### Expected student activities

Active participation in exercise sessions is essential.

### Assessment methods

30% midterm exam

70% final exam

### Supervision

Office hours	Yes
Assistants	Yes
Forum	No

### Resources

#### Bibliography

Introduction to Probability Models, 10th edition, Sheldon M. Ross, Academic Press, 2009.

Dynamic Programming and Optimal Control, 3rd edition, Dimitri P. Bertsekas, Athena Scientific, 2005.

Introduction to Probability, Dimitri P. Bertsekas and John N. Tsitsiklis, Athena Scientific, 2002.

#### Ressources en bibliothèque

- [Dynamic Programming and Optimal Control / Bertsekas](#)
- [Introduction to Probability Models / Ross](#)
- [Introduction to Probability / Bertsekas](#)

### Prerequisite for

Advanced MTE courses