

## Course

# Advanced Inventory Theory

<b>Date:</b>	<b>14 &amp; 28 March, 11 &amp; 25 April 2018</b>
<b>Time:</b>	<b>10.00 – 16.00 h.</b>
<b>Location:</b>	<b>Utrecht, Boswell-Beta, Laan van Puntenburg 2A</b>
<b>Course leaders:</b>	<b>Prof. Rommert Dekker and Prof. Geert-Jan van Houtum</b>
<b>Days:</b>	<b>4</b>
<b>ECTS:</b>	<b>1 (attendance) / 4 (attendance + assignment)</b>
<b>Course fee:</b>	<b>Free for TRAIL/Beta/OML members, others please contact the TRAIL office</b>
<b>Registration:</b>	<a href="http://www.gp-oml.nl">www.gp-oml.nl</a>

### Objectives

- Students will learn an exact analysis for relatively simple inventory models
- Students will learn what can be done via approximate performance evaluation when an exact performance evaluation is not possible.
- Students will learn about heuristics for cases where an exact optimization is not possible or has a too high computational complexity.
- Students will be exposed to open research problems.

### Course description

We discuss two types of inventory models:

1. Single-location inventory models for inventories in general,
2. Spare parts inventory models.

The first part will be mainly based on chapters of the book of Axsäter (2015). We start with various single-location, single-item inventory models, and analyze e.g. base stock policies,  $(r,Q)$  policies, and  $(s,S)$  policies. Next, we study a setting with multiple inventory items and joint ordering costs (the well-known “joint replenishment problem”). We present heuristic as well as exact approaches to the problem, both in a deterministic and stochastic setting. Finally, we consider models for multiple demand classes and show that under certain conditions critical level policies are optimal. We present algorithms for finding the optimal critical level policy for multiple demand classes.

The second part will be based on Chapters 3, 5 and 6 of the book of Van Houtum and Kranenburg (2015). In spare parts inventory problems, the focus is generally on the system availabilities of the machines for which spare parts are taken on stock. This leads to multi-item inventory models with various types of system-oriented service level constraints. We show how to derive efficient solutions in a single-location setting with one type of customers, and we formulate heuristics. Next, we study a single-echelon, multi-location setting with lateral transshipments and a two-echelon distribution setting (the “METRIC model”). We also show how these models can be and actually are applied in practice. Finally, we connect the single-echelon, multi-location model to settings for internet sales, library books, and ambulance services.

Connection with the course “Quantitative Modelling and Analysis of Supply Chains QMASC”:

The latter course is about inventories in general and as such mainly related to our first part. While we focus on single-location models, and especially in settings with multiple items and joint replenishment costs and with multiple demand classes, the course QMASC has a focus on multi-echelon production/inventory systems.

## Assignment

Two sets of homework exercises.

## Course materials

- Axsäter, S., Inventory Control, 3<sup>rd</sup> edition, Springer, 2015. (Chapters 3-7)
- Van Houtum, G.J., and Kranenburg, A.A., Spare Parts Inventory Control under System Availability Constraints, Springer, 2015. (Chapter 1, Sections 2.1-2.5, Chapters 3, 5, and 6)
- Handouts

## Methodology

In this course, various quantitative/mathematical models for inventory problems are discussed.

## Prerequisite

- Basic probability theory.
- Basic knowledge of Markov processes and queueing theory (M|M|1, M|G| $\infty$ , M|G|c|c queue). If you miss this part of the prerequisite, you can study chapters on these topics in a standard text book on Operations Research; see e.g. Chapter 17 on "Markov Chains" (up to and including Section 17.6, pp. 923-950) and Chapter 20 on "Queueing Theory" (up to and including Section 20.8, pp. 1051-1098) of Winston [2004], "Operations Research: Applications and Algorithms" (4-th edition), Brooks/Cole-Thomson Learning, Bement, CA, U.S.A.

## Lecture scheme and preparation

- **First and second lecture day:** First type of inventory models, by prof. Dekker. Participants without background in inventory control should study chapter 3 (cost structure and concepts) and chapter 5 sections 5.1 to 5.10).
- **Third and fourth lecture day:** Second type of inventory models, by prof. Van Houtum. Participants who did not have any inventory theory course until now, can prepare themselves for this part by studying Sections 2.1-2.5 of Van Houtum and Kranenburg (2015); this part of the book can be downloaded as free sample pages at <http://www.springer.com/cn/book/9781489976086>. In these sections, the basic multi-item spare parts model is analyzed. This basic model forms a basis for the models of Chapters 3, 5, and 6, and is relatively easy for participants who had an inventory theory course during their master program; this model will be discussed only briefly at the third lecture day.