PhD Course Schedule:

Optimization in dynamic and stochastic decision problems,

PFG0039 7.5 credits
Swedish University of Agricultural Sciences (= SLU), SE-901 83 Umea, Sweden
Organizer and Professor: Peter Lohmander
Contact: Peter@Lohmander.com
Version 2011-02-15

Time Period:
Start: Monday 2011-02-21 Stop: Friday 2011-03-25

Location:
Swedish University of Agricultural Sciences (= SLU), Umeå, Sweden. The lectures take place in the seminar room of the department of forest economics.

Course Structure:
All parts of the course focus on the general theme: "Optimization in dynamic and stochastic decision problems." The course includes lectures on general theory and methodology and numerical solutions via computer programming. The course also includes a number of application examples, as illustrations of all of the theories and methods. Furthermore, during the course, all course participants develop and solve some applied dynamic optimization problems, that should be of relevance to different research projects. The analyses and results should be presented and discussed during seminars for all participants in the end of the course. Finally, a written examination takes place.

<u>Week 8</u>

Monday	21/2	10.15-12.00	Introduction. Presentations. Practical information. Computer software information. Literature information. Introduction to the Applied Research (more information is found in the later part of the schedule). All course participants download and install "LINGO" and "QBasic" on personal laptops. Software and instructions are available here: http://www.lindo.com/ http://www.lindo.com/index.php?option=com_content&view=article&id=34&Itemid=15 http://www.lindo.com/downloads/PDF/LINGO12.pdf http://en.wikipedia.org/wiki/QBasic http://www.qbasic.com/games/Utilities/QB45.zip	PL
		13.15–16.00	Applied Research and Studies	
Tuesday	22/2	10.15-12.00	Deterministic dynamic programming with discrete state space (Fundamental theory and introductory examples.) Wi1 (Chapter 18) & PL´s examples: http://www.Lohmander.com/DPStock/DPStock.pdf http://www.Lohmander.com/DPStock/DPStock.doc http://www.Lohmander.com/DPStock/DPStock.txt http://www.Lohmander.com/DPStock/DPUT.txt http://www.lohmander.com/AppPro/L6.pdf http://www.lohmander.com/AppPro/L7.pdf http://www.lohmander.com/DHINV/DHINV_example.pdf http://www.lohmander.com/DHINV/Complete_ex2.pdf http://www.lohmander.com/DHINV/DHIN.txt http://www.lohmander.com/DHINV/DHOUT.txt http://www.lohmander.com/DHINV/DHINV22.zip	PL
		13.15–16.00	Applied Research and Studies	
Wednesday	23/2	10.15-12.00	Stochastic dynamic programming with discrete state space (Fundamental theory and introductory examples.) Wi1 (Chapter 19) & PL´s examples: http://www.lohmander.com/STStock/STStock.pdf http://www.lohmander.com/STStock/STStock.doc http://www.lohmander.com/STStock/STStock_txt.txt http://www.lohmander.com/STStock/STUT_txt.txt http://www.lohmander.com/UPV/Lohmander_UPV_07.ppt http://www.lohmander.com/UPV/Lohmander_UPV_07.ppt http://www.lohmander.com/UPV/Lohmander_UPV_07.ppt http://www.lohmander.com/UPV/Lohmander_UPV_07.ppt (Pages 1 - 36) http://www.lohmander.com/AppPro/L7.pdf http://www.lohmander.com/UPV/Lohmander_UPV_08.ppt http://www.lohmander.com/SDO.ppt http://www.lohmander.com/program/javakod/D2.htm http://www.lohmander.com/program/javakod/D2.htm	PL
		13.15–16.00	Applied Research and Studies	
Thursday	24/2	10.15-12.00	Linear programming (Fundamental theory, duality and complementary slackness) Ba (Pages 127 – 133), Wi1 (Chapters 3-6) & PL´s examples: http://www.lohmander.com/AppPro/L1.pdf http://www.lohmander.com/AppPro/L2.pdf http://www.lohmander.com/AppPro/L3.pdf http://www.lohmander.com/SDO.ppt (until page 50)	PL
		13.15–16.00	Applied Research and Studies	
Friday	25/2	10.15-12.00	Deterministic dynamic programming in Markov chains (Combination of linear programming and dynamic programming.) (Fundamental theory and introductory examples.) Wi1 (Briefing Chapter 17) & PL´s examples: http://www.lohmander.com/AppPro/L7.pdf	PL

		13.15–16.00	Applied Research and Studies	

Week 9

Monday	28/2	10.15-12.00	Stochastic dynamic programming in Markov chains (Combination of linear programming and dynamic programming.) (Fundamental theory and introductory examples.) Wi1 (Page 1042) & PL´s examples: http://www.lohmander.com/Vermont2.ppt http://www.lohmander.com/SDO.ppt	PL
		13.15–16.00	Applied Research and Studies	
Tuesday	1/3	10.15-12.00	Linear programming (with multi period examples) Wi1 Wi1 (Briefly chapters 3-6, Sections 3.10 – 3.12) & PL´s examples: http://www.lohmander.com/kurser/MODFOR02/MODFOR_DLP5.doc http://www.lohmander.com/program/Avv_SVL/InAvSv8.html	PL
		13.15–16.00	Applied Research and Studies	
Wednesday	2/3	10.15-12.00	Quadratic programming (with multi period examples) Wi1 (Section 11.10) & PL´s examples: http://www.lohmander.com/AppPro/L4.pdf http://www.lohmander.com/London09.pdf http://www.lohmander.com/London09/London_Lohmander_09.ppt http://www.lohmander.com/Moscow10/Moscow10_PL.pdf http://www.lohmander.com/Moscow_2010/Lohmander_Moscow_2010.ppt	PL
		13.15–16.00	Applied Research and Studies	
Thursday	3/3	10.15-12.00	General nonlinear programming (with multi period examples) Wi1 (Briefly chapter 11) & PL´s examples: http://www.lohmander.com/Moscow_2010/Lohmander_Zazykina_Moscow_2010.ppt http://www.lohmander.com/Moscow10/Moscow10_PL_LZ.pdf	PL
		13.15–16.00	Applied Research and Studies	
Friday	4/3	10.15-12.00	Differential equations and differential equation systems (Fundamental methods and examples) Bl (& PL´s examples) http://www.youtube.com/watch?v=fQs8316uri0&NR=1 http://www.youtube.com/watch?v=bLb52vHMa_c&feature=related http://www.youtube.com/user/khanacademy#p/c/96AE8D9C68FEB902/0/-_POEWfygmU	PL
		13.15–16.00	Applied Research and Studies	

<u>Week 10</u>

Monday	7/3	10.15-16.00	Applied research. The course participants optimize some dynamic and stochastic decision problems, of relevance to different research projects, based on theory presented during week 8 and/or week 9. The analyses and results will be presented and discussed during the "Course participant seminars I", in the end of the course. *(Peter Lohmander at Systems Analysis in Forestry, Chile)*	
Tuesday	8/3	10.15-16.00	Applied research. *(Peter Lohmander at Systems Analysis in Forestry, Chile)*	
Wednesday	9/3	10.15-16.00	Applied research. *(Peter Lohmander at Systems Analysis in Forestry, Chile)*	
Thursday	10/3	10.15-16.00	Applied research. *(Peter Lohmander at Systems Analysis in Forestry, Chile)*	
Friday	11/3	10.15-16.00	Applied research. *(Peter Lohmander at Systems Analysis in Forestry, Chile)*	

<u>Week 11</u>

Monday	14/3	10.15-12.00	Deterministic optimal control theory in continuous time (Fundamental theory developed via dynamic programming theory.) Se (27-36) Taylor functions (necessary in order to understand optimal control): http://www.youtube.com/user/DrChrisTisdell#p/c/EC77189667CA70CA/22/jjltTORF2Jg & PL´s presentation (Pages 1-22): http://www.lohmander.com/CM/CMLohmander.ppt	PL
		13.15–16.00	Applied Research and Studies	
Tuesday	15/3	10.15-12.00	Deterministic optimal control theory in continuous time (Fundamental optimal control examples) Se (36-44) & PL´s presentation (Pages 23-140): http://www.lohmander.com/CM/CMLohmander.ppt http://www.lohmander.com/CM/CM.htm	PL
		13.15–16.00	Applied Research and Studies	
Wednesday	16/3	10.15-12.00	Stochastic optimal control theory in continuous time (Fundamental theory developed via dynamic programming theory.) Se (13.2-13.2), Wi2 (693-697, 704-707) Random walk: http://www.youtube.com/watch?v=OBT0Rzl5SAU (1D) http://www.youtube.com/watch?v=9mS6v4YY1qQ&feature=related (2D) http://www.youtube.com/watch?v=zLoolkCnwOo&feature=related (3D) Brownian motion : http://www.youtube.com/watch?v=PtYP8uoN0lk&feature=related Partial differential equations : http://www.youtube.com/watch?v=ezH88VekVWU&feature=related & PL´s document (Pages 1-2): http://www.lohmander.com/optctrl_110201_PL.pdf	PL
		13.15–16.00	Applied Research and Studies	
Thursday	17/3	10.15-12.00	Applied Research and Studies	
		13.15–16.00	Applied Research and Studies	
Friday	18/3	10.15-12.00 & 13.00–15.00	**Course participant seminars I.** All course participants present and discuss applications of optimization in dynamic and stochastic decision problems, of relevance to different research projects, based on theory presented during week 8 and/or week 9.	PL

Week 12

Monday	21/3	10.15-12.00	Applied Research and Studies	
		13.15–16.00	Applied Research and Studies	
Tuesday	22/3	10.15-12.00	Stochastic optimal control theory in continuous time (Fundamental optimal control examples) (Se) Wi2 (***) & PL´s examples: http://www.lohmander.com/optctrl_110201_PL.pdf http://www.lohmander.com/optctrl_110201_PL.doc	PL
		13.15–16.00	Applied Research and Studies	
Wednesday	23/3	10.15-12.00	Stochastic optimal control theory in continuous time (Optimal control examples) (PL´s examples) http://www.lohmander.com/OptCCS/OptCCS.ppt http://www.youtube.com/watch?v=sLaez4Fcfh8 (Other partial differential equation) http://www.youtube.com/watch?v=acOUMbRqDyw&feature=related (PDE solution)	PL
		13.15–16.00	Applied Research and Studies	
Thursday	24/3	10.15-12.00 & 13.15–15.00	**Course participant seminars II.** All course participants present and discuss applications of optimization in dynamic and stochastic decision problems, of relevance to different research projects, based on theory presented during week 11 and/or week 12.	PL
		13.15–16.00	Applied Research and Studies	
Friday	25/3	09.15-15.00	**FINAL TEST and course evaluation.**	PL

Literature (General Theory and Methodology):

Relevant parts (chapters and pages etc. are written directly in the schedule!) of:

Ba   Baumol, W., Economic Theory and Operations Analysis, 4 ed., 1976.

Bl   Blanchard, P., Devaney, R.L., Hall, G.H., Differential Equations, Thomson Brooks/Cole, ISBN 0-495-01265-3, 2006

Se   Sethi, S. P., Thompson, G.L., Optimal Control Theory, Applications to Management Science and Economics, Kluwer Academic Publishers, 2 ed., 2000

Wi1 ***   Winston, W.L., Operations Research, Applications and Algorithms, Duxbury Press, International Thomson Publishing, ISBN 0-534-20971-8, 2004

Wi2   Winston, W.L., Introduction to Probability Models, Operations Research: Volume Two, Duxbury, Thomson Brooks/Cole, ISBN 0-534-42339-0, 2004

PL´s examples   (Linked documents by Peter Lohmander.)

PFG0039 Optimization in dynamic and stochastic decision problems, 7.5 credits

Optimering i dynamiska och stokastiska beslut problem
Syllabus approved: 2010-06-22
Subject:
Education level: level
Marking scale: Pass / Failed
Prerequisites:
The participants should have some knowledge of calculus, linear and nonlinear optimization before the course starts.

The course is intended for:
PhD students in management, economics, business administration, forest management, engineering and all other sciences where dynamic and stochastic optimization problems are relevant and important.

Objectives:
Economic dynamic and stochastic decision problems.
Deterministic dynamic optimization in discrete time with discrete state space.
Deterministic dynamic optimization in discrete time with continuous state space.
Deterministic dynamic optimization in continuous time.
Optimal solutions to deterministic dynamic decision problems.
Stochastic dynamic optimization in discrete time.
Stochastic dynamic optimization in continuous time.
Optimal solutions to stochastic dynamic decision problems.
Applications to decision problems in forest company management in forest production, forest logistics and forest industry mills. (It does not matter if the course participant mainly is interested in the forest sector or some other sector. The decision problems are very similar in most sectors and the solution methods are the same.)

Contents:
Economic dynamic and stochastic decision problems.
Deterministic dynamic optimization in discrete time with discrete state space.
Deterministic dynamic optimization in discrete time with continuous state space.
Deterministic dynamic optimization in continuous time.
Optimal solutions to deterministic dynamic decision problems.
Stochastic dynamic optimization in discrete time.
Stochastic dynamic optimization in continuous time.
Optimal solutions to stochastic dynamic decision problems.
Applications to decision problems in forest company management in forest production, forest logistics and forest industry mills. (It does not matter if the course participant mainly is interested in the forest sector or some other sector. The decision problems are very similar in most sectors and the solution methods are the same.)

Literature:
Relevant parts of:
- Sethi, S. P., Thompson, G.L., Optimal Control Theory, Applications to Management
Science and Economics, Kluwer Academic Publishers, 2 ed., 2000
- Winston, W.L., Operations Research, Applications and Algorithms, Duxbury Press,
International Thomson Publishing, ISBN 0-534-20971-8, 2004
- (More applications will be included.)

Examination:
Written exam and seminar presentations of problem solutions.

Responsible department
Department of Forest Economics

Location
Umeå