



Bus Q782: Dynamic Programming and Optimal Control Fall 2025 Course Outline

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Operations Management Area
DeGroote School of Business
McMaster University

1 COURSE OBJECTIVE

This course is designed to familiarize Business PhD students with the fundamental tools used in dynamic optimization to solve operations management and related problems.

2 PREREQUISITES

- Registration in the PhD program at DeGroote School of Business, or permission of the instructor.

3 INSTRUCTOR AND CONTACT INFORMATION

Dr. Mahmut Parlar

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<https://parlar.azurewebsites.net/index.html>

<http://avenue.mcmaster.ca/>

- First class is on **September 2, 2025 (Tuesday)**. (See Mosaic for classroom)
- Cancelled classes : September 16 and 30, 2025. (Makeup classes later.)

- The assignments must be handed in to the instructor in hard-copy (paper) form. **Please start each question on a new page and use only one side of the paper.**

4 COURSE WEBSITE (reachable from...)

<http://avenue.mcmaster.ca/>

- Please upload a recent photo to Avenue.

5 COURSE DESCRIPTION

Many realistic business problems in operations, finance and marketing and problems in economics involve control of dynamic systems which evolve over time. This course will provide a rigorous foundation for dynamic optimization of such systems by covering dynamic programming and optimal control. The basic discrete-time dynamic programming algorithm will be illustrated with applications in inventory control, dynamic portfolio analysis and linear quadratic systems. Optimal control of continuous-time systems will be covered using maximum principle with applications in operations, finance, marketing and economics.

6 LEARNING OUTCOMES

At the end of the course the students will be able to formulate and solve dynamic optimization problems arising in business decisions using dynamic programming and optimal control theory.

7 COURSE MATERIALS AND READINGS

7.1 Books

- Bather [DP] [1]
- Bellman [DP] [2]
- Bensoussan, Kleindorfer and Tapiero [OC] [3]
- Bertsekas [DP] [4], [5]
- Bryson and Ho [OC] [6]
- Connors and Teichroew [OC] [7]
- Cooper and Cooper [DP] [8]
- Denardo [DP] [9]

- Dreyfus and Law [DP] [10]
- Hillier and Lieberman [DP] [11, Ch. 10]
- Intriligator [DP + OC] [12]. This book has a nice chapter on differential games, too.
- Kamien and Schwartz [OC] [13]. This book has a nice chapter on differential games, too.
- Kirk [OC] [14]
- Nemhauser [DP] [15]
- Parlar [DP + OC] [16, Ch. 6]
- Ross [DP] [17]
- Sage and White [18]
- Sasieni, Yaspan and Friedman [19, Ch. 10]
- Sethi [20]
- Sethi and Thompson [OC] [21] (★ Available online @ McMaster library) This book has a nice chapter on differential games, too.
- Tapiero [OC] [22] [23] [24]
- Winston [25, Chs. 6 and 7]

7.2 Papers

All of my published papers on dynamic programming and optimal control are available on Avenue.

7.3 SUGGESTED READING & SOFTWARE / WEB LINKS

7.3.1 Software and web resources

Main software resource

- Maple files
- My `StageCoach.xlsx` file

Supplementary online resources

- Suresh Sethi's textbook:
 - https://archive.org/details/springer_10.1007-0-387-29903-3
- Wikipedia articles
 - https://en.wikipedia.org/wiki/Dynamic_programming
 - https://en.wikipedia.org/wiki/Optimal_control

8 EVALUATION

8.1 Components and Weights

The components of the course grade will be weighted as follows.

Component	Weight
Two assignments	20%
Midterm exam	30%
Final exam	50%
TOTAL	100%

8.2 Conversion

At the end of the course your overall percentage grade will be converted to your letter grade in accordance with the following conversion scheme.

Grade (Points)	Percent
A+ (12)	90–100
A (11)	85–89
A– (10)	80–84
B+ (9)	77–79
B (8)	73–76
B– (7)	70–72
F (0)	0–69

9 COURSE SCHEDULE

1. Deterministic Dynamic Programming

- (a) Network Models

- i. Stagecoach Problem
 - ii. Production/Inventory Problem
 - iii. Knapsack Problem
 - (b) Models with Linear System and Quadratic Cost
 - i. Basic LQ Model
 - ii. Solution as an NLP Problem
 - iii. A More General LQ Model (Almost Closed-Form Solution)
 - iv. Infinite Stage Problem and Successive Approximations
 - v. Discounted Cost Model
 - (c) Analytic Solutions
 - i. A Problem in Division
 - ii. A QP Problem Solved Using DP
 - iii. Consumption-Investment Problem
 - iv. Continuous-Time Dynamic Programming and HJB Equation
 - v. Remark on Discounting when $T \rightarrow \infty$
 - vi. Infinite Horizon LQ Problem (HJB Solution)
2. Stochastic Dynamic Programming
- (a) Network Models
 - i. Stochastic Stagecoach Problem
 - ii. Stochastic Production/Inventory Problem
 - (b) Structural Results
 - i. Optimality of the Base-Stock Policy
 - ii. Problem with Linear System and Quadratic Cost—Certainty Equivalence Principle
 - iii. A Gambling Problem with Myopic Optimal Policy
 - iv. Optimal Rationing Policies
 - (c) Further Examples
 - i. Optimal Stopping Problems
 - ii. Maximizing the Probability of a Favourable Event
3. Deterministic Optimal Control
- (a) Basic Concepts and the Formulation of Simple Control Models
 - (b) The Continuous-Time Maximum Principle and HJB Equation (Revisited)
 - (c) Economic Interpretation of the Maximum Principle

- (d) Elementary Examples
 - (e) Mixed Inequality Constraints
 - (f) General Inequality Constraints
 - (g) Applications
 - i. Production/Inventory Applications
 - ii. Finance Applications
 - iii. Revenue Management Applications
 - iv. Other Applications
4. Stochastic Optimal Control (Time permitting)
- (a) Itô Calculus and the HJB Equation
 - (b) Stochastic Production Planning Model
5. Differential Games
- (a) Zero-Sum Differential Games
 - (b) Non-Zero Sum Differential Games: Open-Loop and Feedback Policies

10 ACADEMIC DISHONESTY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at:

★www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

11 MISSED ACADEMIC WORK

Late assignments will not be accepted. No extensions are available except under extraordinary circumstances. Please discuss any extenuating situation with your instructor at the earliest possible opportunity.

12 POTENTIAL MODIFICATIONS TO THE COURSE

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

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★ <http://www.copyright.mcmaster.ca/>

14 STUDENT ACCESSIBILITY SERVICES

Student Accessibility Services (SAS) offers various support services for students with disabilities. Students are required to inform SAS of accommodation needs for course work at the outset of term. Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca.

For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities:

★<http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicAccommodation-StudentsWithDisabilities.pdf>

References

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