Athabasca University

Mathematics (MATH) 481

Mathematical Modeling II (Revision 1)

Delivery Mode:	Individualized Study Online
Credits:	3
Area of Study:	Science
Prerequisites:	MATH 265, MATH 266, MATH 270, MATH 309 and MATH 480, or equivalent courses from another university. MATH 376 and MATH 476 is recommended, but not required.
Precluded:	None
Challenge:	MATH 481 is not available for Challenge.
Faculty:	Faculty of Science and Technology
Status:	Replaced with new revision, see the course listing for the current revision
Notes:	To complete this course successfully, students will require access to Microsoft Excel software (2010 or later) to go through worked examples and to complete several of the assignments. Another

system, Maxima (a computer algebra system) is optional. The source code for Maxima can be freely downloaded from the Internet, and instructions for application are provided in the textbook (Velten, 2009).

Overview

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Mathematics 481 is designed to provide a foundation in mathematical modeling, with an emphasis on numerical methods and simulation modeling. In *Math 481* you will learn a variety of mathematical modeling approaches with applications in physical sciences, social sciences, finance, medicine, and business. As with its predecessor course *Math 480: Mathematical Modeling I*, this course does not emphasize the presentation of new mathematical theory, but rather, it teaches the application of known mathematical methods to real-world cases. The course examines both observational and explanatory models, though the emphasis is on the latter. Topics include stochastic modeling approaches such as Markov Processes and Discrete Event simulation, as well as deterministic approaches that use ordinary differential equations and partial differential equations. We will also introduce the concepts of optimization and learn how to pose and solve optimization problems via various modeling approaches.

A key approach in this course is giving students the opportunity to build models —both analytic and simulation models—themselves. As such, each topic is broken into two sections. The first section focuses on the theory behind the modeling approach, including methods for analyzing the model. The second section focuses on numerical methods and development of simulation models, using Microsoft Excel.

Outline

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- Unit 1: Introduction to Modeling and Simulation
- Unit 2: Empirical Models
- Unit 3: Markov Chains and Discrete Event Simulation
- Unit 4: Ordinary Differential Equations: Mathematical Methods
- Unit 5: Ordinary Differential Equations: Numerical Methods
- Unit 6: Partial Differential Equations: Mathematical Methods
- Unit 7: Partial Differential Equations: Numerical Methods
- Unit 8: Linear Programming Models

Learning Outcomes

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Upon successful completion of this course, you should be able to

- differentiate between types of mathematical models, including empirical vs. theoretical, static vs. dynamic, and stochastic vs. deterministic.
- model deterministic dynamical systems using appropriate techniques (e.g., ODEs and PDEs) and numerical methods (e.g., Euler's, Runge-Kutta's, and finite difference).
- model stochastic dynamical systems using Markov chains and discrete event simulation.
- model optimization problems using linear programming models; state and apply the fundamental duality theorem and analyze the models, with and without computer software.

Evaluation

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To **receive credit** for MATH 481, you must achieve a cumulative grade of at least **C— (60 percent)** overall, a cumulative grade of at least C— (60 percent) on Assignments 1-8, and a cumulative grade of C— (60 percent) on Assignment 9 and the Final Exam.

The weighting of the composite grade is as follows:

Activity	Weight
Assignment 1-8 (5% each)	40%
Assignment 9	30%
Final Exam	30%
Total	**100%**

To learn more about assignments and examinations, please refer to Athabasca University's **online Calendar** .

Materials

Materials

Maki, D., & Thompson, M. (2006). *Mathematical modeling and computer simulation*. New York: Thompson, Brooks/Cole. (Print)

Velten, K. (2009) *Mathematical modeling and simulation: Introduction for scientists and engineers*. Weinheim: Wiley-VCH Verlag GMbH & Co. (Print)

Other Materials

The course materials also include course information, a study guide, assignments, and Microsoft Excel example files.

Important Links

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- Academic Advising
- Program Planning
- Request Assistance
- Support Services

Athabasca University reserves the right to amend course outlines occasionally and without notice. Courses offered by other delivery methods may vary from their individualized-study counterparts.

Opened in Revision 1, March 31, 2016

Updated January 17, 2022, by Student & Academic Services