FLORIDA POLYTECHNIC UNIVERSITY

# Course Information

- **Course Number and Title**: MAP 4202: Optimization Theory
- **Credit Hours:** 3
- **Academic Term:** Spring 2026

# Instructor Information

- **Instructor:** Dr. Alexander Joyce
- **Office Location:** IST-2022
- **Office Hours**: Mon 12:00 pm-1:00 pm, Tue 1:00 pm-2:00 pm, Wed 11:00 am -12:00 pm, and by appointment
- **Email address**: ajoyce@floridapoly.edu

# Course Delivery and Course Description

- **Delivery Mode**: Face-to-face; MWF 1:00 pm-1:50 pm, IST 1015
- **Course Website**: https://floridapolytechnic.instructure.com/
- **Official Catalog Course Description**: This course will focus on problem formulation, software technologies and analytical methods for optimization serving as an introduction to a wide variety of optimization problems and techniques including linear and nonlinear programming, dynamic programming, network flows, integer programming, heuristic approaches, Markov chains, game theory, and decision analysis.
    - **Course Pre and/or Co-Requisites**: MAS 3105 - Linear Algebra or MAS 3114 - Computational Linear Algebra
    - **Communication/Computation Skills Requirement (6A-10.030)**: N
- **Required Texts and Materials:**
    - Required textbook: *Introduction to Linear Optimization*, Dimitris Bertsimas and John N. Tsitsiklis, Athena Scientific, ISBN-10: 1-886529-19-1, ISBN-13: 978-1-886529-19-9
    - Supplementary free online textbook: *Convex Optimization*, Stephen Boyd and Lieven Vandenberghe, Cambridge University Press, URL: https://web.stanford.edu/~boyd/cvxbook/bv_cvxbook.pdf
    - Supplementary free online textbook: *Mathematics for Machine Learning*, Mark Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, Cambridge University Press, URL: https://mml-book.github.io/book/mml-book.pdf
    - Electronic devices such as laptops and calculators are recommended for use in class. Homework assignments and projects will require some programming with MATLAB, which can be accessed by students for free through the virtual app page.

# Course Objectives and Outcomes

- **Course Objectives**: At the end of this course, you should have a solid understanding of the major applications of optimization-based mathematical models and the principles behind their solution methods. You will learn about some of the major families of optimization problem and some of their solution methods. You will be able to formulate an optimization model for addressing a practical problem, and to design a reasonable solution approach based on the properties of the resulting model. You will gain hands-on experience in deriving analytical results by hand and then using those results to formulate and implement an efficient solution algorithm in the form of a computer program.
- **Course Learning Outcomes**: The following topics will be used to measure the student learning outcome "Demonstrate fluency in mathematics concepts", which corresponds to the Mathematics Reasoning Competency:
  1. Write an appropriate optimization-based mathematical model to address a given practical problem.
  2. Select and justify an appropriate solution method based on the properties of a given optimization problem.
  3. Implement a computationally efficient solution algorithm for an optimization problem.
  4. Demonstrate a working understanding of theoretical results for linear programs and the simplex method.
  5. Demonstrate a working understanding of theoretical results for convex programs and descent methods.
- **Alignment with Program Outcomes**:

| **Course Learning Outcome** | **Learning Level**<br><br>**(Anderson/ Krathwohl)** | **Program Learning Outcome**<br><br>**(ABET/GenEd)** |
|---|---|---|
| Write an appropriate optimization-based mathematical model to address a given practical problem. | Creating | ABET: 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.<br><br>GenEd: Apply appropriate mathematical techniques and problem-solving strategies to produce valid results. |
| Select and justify an appropriate solution method based on the properties of a given optimization problem. | Analyzing | ABET: 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.<br><br>GenEd: Apply appropriate mathematical techniques and problem-solving strategies to produce valid results. |
| Implement a computationally efficient solution algorithm for an optimization problem. | Applying | ABET: 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.<br><br>GenEd: Apply appropriate mathematical techniques and problem-solving strategies to produce valid results. |

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| Demonstrate a working understanding of theoretical results for linear programs and the simplex method. | Understanding | ABET: 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.<br><br>GenEd: Demonstrate fluency in mathematical concepts. |
| Demonstrate a working understanding of theoretical results for convex programs and descent methods. | Understanding | ABET: 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.<br><br>GenEd: Demonstrate fluency in mathematical concepts. |

# Course Policies

## Attendance

Students are expected "to attend all of their scheduled University classes and to satisfy all academic objectives as defined by the instructor" (University Policy, FPU-5.0010AP).

## Participation

Students are expected to participate in the classroom experience. The use of earbuds/headphones during class is specifically not allowed and students who engage in this behavior may be asked to leave the class for the day (noting exceptions for authorized accommodations). Persistent problems with participation may result in a code of conduct referral.

## Late Work/Make-up work

Make-up exams and late assignment submissions will be permitted only for excused absences with appropriate written documentation. If at all possible notification should be given beforehand so that alternate arrangements can be made. Make-ups for in-class assignments will not be allowed, but these assignments may be waived in case of excused absence on a case-by-case basis.

Unexcused late or incomplete assignment submissions will not be accepted for any reason, including technical errors with submission through Canvas, so be sure to submit early in order to avoid unexpected delays. If you are unable to submit your work on time, email what you have to your instructor immediately to demonstrate that you've made a good-faith effort to complete the assignment as requested. Exceptions and extensions may be permitted on a case-by-case basis.

## Grading Scale

| Grade | A | B+ | B | C+ | C | D | F |
|---|---|---|---|---|---|---|---|
| Percentage | 90% | 87% | 80% | 77% | 70% | 60% | < 60% |
| GPA | 4.0 | 3.33 | 3.0 | 2.33 | 2.0 | 1.0 | 0.0 |

# Assignment/Evaluation Methods

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|---|---|
| Homework | 20% |
| Quizzes | 5% |
| Exam 1 | 15% |
| Exam 2 | 15% |
| Exam 3 | 15% |
| Final Project Report | 20% |
| Final Project Presentation | 10% |
| Total | 100% |

- **Homework:** Homework assignments will be due approximately once every two weeks, and will include a combination of problems from the textbook, off-book problems, and programming assignments. Due dates and problem lists will be posted on Canvas, but assignments are generally due on Sunday evenings.

  Solutions should be submitted through Canvas, and must consist of legible, logical work that clearly communicates your solution process using correct mathematical notation. The specific submission format may differ by assignment, but in general you should submit (1) a single PDF containing all of your work and solutions and (2) a single file related to the coding assignment.

  Homework will be graded based on the correctness of your work as well as the quality of your presentation. A bonus of +5% will be added for submitting well-typeset work (e.g. using LaTeX; Overleaf is a popular online LaTeX editor, and an extremely comprehensive guide to LaTeX can be found at https://tobi.oetiker.ch/lshort/lshort.pdf).

  The homework sets for this course are meant to help you to understand the course material on a deeper level, as well as to evaluate your ability to work with complicated ideas to solve difficult problems. **You may** discuss the assignments with each other, but the work you present must be your own. **You may not** seek help online by looking up solution guides or visiting a homework help forum. If you have questions or require some guidance, please visit my office hours or send me an email. Due to the high value of the homework assignments in this course, evidence of academic dishonesty (e.g. finding solutions online or copying another student's work) will result in a score of zero for that assignment in addition to disciplinary action by the university.

  The homework assignments will be challenging and time-consuming, and will span multiple weeks' worth of course material. As such you should be in the habit of starting them early, working on what problems you can as soon as we cover the relevant material in class. At the end of the semester your lowest homework score will be dropped.

- **Quizzes:** Periodically, brief assignments will be handed out in class to be submitted either later during the same class period or the next class day. The dates for these in-class assignments will be announced one week ahead of time. At the end of the semester your lowest worksheet score will be dropped.

- **Exams:** Three in-class exams are scheduled and listed in the calendar below. The exams are meant to evaluate your understanding of the concepts covered in class as well as your ability to perform by hand some of the elementary operations involved in the major algorithms developed in class. If you understand the homework assignments, then the exams should be no trouble.

  You will be allowed one piece of 8.5" x 11" paper, with whatever you wish to have written on it. You are allowed (and encouraged) to bring a standalone calculator, but no computers, phones, smart watches, or internet-connected devices will be allowed.

- **Final Project Report and Presentation:** A final group project will be assigned at the beginning of the semester. The projects will cover a formulation/method used in linear programming/nonlinear programming with an accompanying application problem. Students will be in a team of 2-3 people and will submit a preference rating of the following formulations/methods:
    - **Dantzig-Wolfe Decomposition**
    - **Online Optimization**
    - **Multi-objective Optimization**
    - **Concept from Combinatorial Optimization**

  Each project will involve a written report and a presentation. No class time will be dedicated to working on these projects, so your team will need to meet outside of class to complete them. Progress check-ins will also be scheduled, during which your team will meet with me in my office to discuss how your project is going and what you should work on moving forward. While the application problem and details for required content for the deliverables will be provided by the **end of January**, a small description of the required deliverables is below:

  **Written Report:** The written report will be a detailed technical paper that describes your assigned formulation/method, your assigned problem, and how you applied the formulation/method to the assigned problem. The report should detail your methodology, implementation, and computational results. If any computer code is used/required, then it must be provided with an explanation.

  **Presentation:** The presentation will be a 15-20 minute presentation discussing your formulation/method, why it is useful/important, your assigned problem, and your implementation of the formulation/method in solving the problem. In short, this is a summary of the written report, followed by a small Q&A. The presentations are scheduled before the report due date to give feedback and to provide an opportunity to make potential revisions before submitting the report. The presentations are tentatively scheduled as follows:

| Monday, April 20th | Wednesday, April 22th |
|---|---|
| Dantzig Wolfe Decomposition<br><br>Concept from Combinatorial Optimization | Online Optimization<br><br>Multi-objective Optimization |

  The purpose of the final project is to give you some experience in doing the kind of work that professional applied mathematicians do in solving a problem completely from beginning to end, from the initial formulation of an optimization-based mathematical model through the development and implementation of a solution algorithm, and finally the communication of those results to your colleagues. As such it is expected that you will produce high-quality work, professionally presented, to a standard that you can be proud of.

  While it is expected that the members of your team will delegate work and that some members may work more on certain aspects of the project than others (e.g. having one person focus more on analytical results and one focus more on the programming), every team member must participate in every aspect of the project, and every member should be fully prepared to explain everything their team did. You may make use of results from external sources (textbooks, research papers, etc.) in your work as long as you clearly indicate and cite these sources. Copying work without attribution is a serious violation of academic integrity, and evidence of plagiarism will result in a score of zero for the entire project in addition to disciplinary action by the university.

  You may find the Florida Poly Library catalog to be a valuable resource for conducting literature reviews and finding previous research to cite. You may also find the Writing Center to be a valuable resource for providing feedback on the style of your presentation and report. If you have questions about the mathematical content of your project, please visit my office hours or send me an email.

# Course Schedule (Subject to Change)

Evaluation dates, assignment due dates, and the topic schedule are subject to change. Refer to the Academic Calendar website for the most up-to-date exam schedule.

| Week | Topics | Notes and Important Dates |
|---|---|---|
| **Week 1**<br>Jan 12– Jan 16 | Course introduction<br>Linear Algebra Primer<br>Optimization-based mathematical models | Mon Jan 12: First Day of Class |
| **Week 2**<br>Jan 19 – Jan 23 | Linear program applications and formulations<br>Graphical Representation of Linear Programs | Monday, Jan 19th: Martin Luther King Jr. Day (No Class)<br>Friday, Jan 23rd: Project Selection |
| **Week 3**<br>Jan 26 – Jan 30 | Graphical Representation of Linear Programs<br>Geometry of Linear Programs | Mon Jan 26: Quiz 1 |
| **Week 4**<br>Feb 2 – Feb 6 | Geometry of Linear Programs<br>Simplex Part 1: Initial development | |
| **Week 5**<br>Feb 9 – Feb 13 | Simplex Part 1: Initial development<br>Simplex Part 2: Implementation details and refinements | **Wed Feb 11: Exam 1** |
| **Week 6**<br>Feb 16 – Feb 20 | Simplex Part 2: Implementation details and refinements<br>Basic Principles of Lagrangian relaxation | Project check-in meetings to be scheduled |
| **Week 7**<br>Feb 23 – Feb 27 | Basic principles of Lagrangian relaxation<br>Duality Theory Part 1: The dual LP | |
| **Week 8**<br>Mar 2 – Mar 6 | Duality Theory Part 2: Properties of the dual LP<br>Dual Simplex<br>Sensitivity Analysis | |
| **Week 9**<br>Mar 9 – Mar 13 | Sensitivity Analysis | **Fri Mar 13: Exam 2** |
| **Week 10**<br>Mar 16 – Mar 20 | **Spring Break** | Mon Mar 16– Fri Mar 20: Spring Break (No Classes) |
| **Week 11**<br>Mar 23 – Mar 27 | Bender's Decomposition | |
| **Week 12**<br>Mar 30– Apr 3 | Basic principles of convex optimization<br>Line Search Methods | |

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| **Week 13**<br>Apr 6 – Apr 10 | Descent Methods Part 1: Initial theory and gradient descent | Project check-in meetings to be scheduled |
| **Week 14**<br>Apr 13 – Apr 17 | Descent Methods Part 2: Practical improvements and Newton's method | |
| **Week 15**<br>Apr 20 – Apr 24 | **Presentation Week** | **Mon Apr 20 – Wed Apr 22: In-class presentations (Check Assignment/Evaluation Methods for exact dates/times)** |
| **Week 16**<br>Apr 27 – May 1 | Exam 3 | **Mon Apr 27: Exam 3 (in-class, covering all material following Exam 1)**<br>**Fri May 1: Project reports due (Canvas)** |

## Academic Support Resources

- **Library**: Students can access the Florida Polytechnic University Library through the University website and Canvas, on and off campus. Students may direct questions to library@floridapoly.edu.
- **Tutoring and Learning Center**: The Tutoring and Learning Center (The TLC) provides tutoring to all Florida Poly students who may need additional academic support. The TLC is staffed by students who have excelled in the courses they tutor. They offer support by reviewing concepts and materials from class, clarifying points of confusion and providing assistance with learning strategies. While the focus of TLC is to provide support to students in freshman-level courses, upper-level courses are also tutored at the Center. The TLC is located in the IST Commons (second floor).
    - **Knack Tutoring**: Students looking for additional assistance outside of the classroom are advised to consider working with a peer tutor through Knack. Florida Polytechnic University has partnered with Knack to provide students with access to verified peer tutors who have previously aced this course. To view available tutors, visit floridapoly.joinknack.com and sign in with your student account.
- **Academic Success Coaches**: All students at Florida Poly are assigned an Academic Success Coach. Your Academic Success Coach can assist you with academic success strategies. Please visit the Student Success Center on the second floor of the IST building to meet with an Academic Success Coach.
- **Writing Center**: Located on the second floor of the IST (2059/2061), the Writing Center helps students to develop their writing and presentation skills. Consultations are available in person and virtually. For more detail, visit floridapoly.edu/writing center.

## Civility and Collegiality

Faculty and students come to the university for the same reason, which is to participate in a highly professional educational environment. To that end, both students and faculty are expected to treat each other with mutual regard and civility. In more general terms, collegiality means respecting the right of both faculty and students to participate fully and fairly in the educational enterprise.

# University Policies

## Reasonable Accommodations

The University is committed to ensuring equal access to all educational opportunities. The University, through the Office of Disability Services (ODS), facilitates reasonable accommodations for students with disabilities and documented eligibility. It is the student's responsibility to self-identify as a student with disabilities and register with ODS to request accommodations.

If you have already registered with ODS, please ensure that you have requested an accommodation letter for this course through the ODS student portal and communicate with your instructor about your approved accommodations as soon as possible. Arrangements for testing accommodations must be made in advance. Accommodations are not retroactive.
If you are not registered with ODS but believe you have a temporary health condition or permanent disability requiring an accommodation, please contact ODS as soon as possible.

The Office of Disability Services (ODS):
DisabilityServices@floridapoly.edu
(863) 874-8770
The Access Point
ODS website: www.floridapoly.edu/disability

## Accommodations for Religious Observances, Practices and Beliefs

The University will reasonably accommodate the religious observances, practices, and beliefs of individuals in regard to admissions, class attendance, and the scheduling of examinations and work assignments. (See University Policy.)

## Title IX

Florida Polytechnic University is committed to ensuring a safe, productive learning environment on our campus that prohibits sex discrimination and sexual misconduct, including sexual harassment, sexual assault, dating violence, domestic violence and stalking. Resources are available if you or someone you know needs assistance. You may speak to your professor, but your professors have an obligation to report the incident to the Title IX Coordinator. Please know, however, that your information will be kept private to the greatest extent possible. You will not be required to share your experience. If you want to speak to someone who is permitted to keep your disclosure confidential, please seek assistance from the Florida Polytechnic University Ombuds Office, BayCare's Student Assistance Program, 1-800-878-5470 and locally within the community at Peace River Center, 863-413-2707 (24-hour hotline) or 863-413-2708 to schedule an appointment. The Title IX Coordinator is available for any questions to discussion resources and options available.

## Academic Integrity

The faculty and administration take academic integrity very seriously. Violations of academic integrity regulation include actions such as cheating, plagiarism, use of unauthorized resources (including but not limited to use of Artificial Intelligence tools), illegal use of intellectual property, and inappropriately aiding other students. Such actions undermine the central mission of the university and negatively impact the value of your Florida Poly degree. Suspected violations will be fully investigated, possibly resulting in an academic integrity hearing and sanctions against the accused student if found in violation. Sanctions range from receiving a zero on the exam or assignment, to expulsion from the university. Repeat offenders are subject to more severe sanctions and penalties.

## Recording Lectures

Students may, without prior notice, record video or audio of a class lecture for a class in which the student is enrolled for their own personal educational use. Recordings may not be used as a substitute for class participation or class attendance. Recordings may not be published or shared in any way, either intentionally or accidently,

without the written consent of the faculty member. Failure to adhere to these requirements is a violation of state law (subject to civil penalty) and the student code of conduct (subject to disciplinary action).

*Recording class activities other than class lectures, including but not limited to lab sessions, student presentations (whether individually or part of a group), class discussion (except when incidental to and incorporated within a class lecture), and invited guest speakers is* ***prohibited****.*