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Department of Engineering, Data and Computer Sciences

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Course Outline – June 2025

Course Title and Code: Applied Optimization Methods, ANA 670
Course Prerequisites: None
Software: Python, free for download
Visual Studio Code, free for download

Course Description: Model optimization problems in a variety of applications of machine learning and artificial intelligence. Identify suitable optimization algorithms for different applications in the industry.

Course Learning Outcomes:
Upon successful completion of this course, students will be able to:

1. Compare and contrast optimization algorithms in a variety of technical applications.
2. Analyze gradient-based optimization methods.
3. Evaluate convex optimization, constrained optimization, and Lagrange multipliers.
4. Implement an evolutionary computation algorithm.

The material covered in this course also introduces and develops the following Program Learning Outcomes (PLOs):

- Use Python for AI and machine learning applications in data science
- Explore optimization methods and algorithms.

Course Schedule, Topics, and Assignments:
In addition to successfully achieving the learning outcomes, students are expected to participate in all class activities, complete exams as scheduled, and turn in all assignments on time (by 11:55 p.m. on the day due). Failure to do so will result in the loss of the points associated with the affected assignment or exam. No assignments will be accepted after solutions have been posted, or after the assignment has been discussed in class.

Module 1: Introduction to Optimization Applications	**Homework**	**Activities**
Lesson 1: History of Optimization and its Applications	Due June 8, 2025 Assignment #1	Due June 4, 2025 Discussion #1
Lesson 2: Mathematical Foundations of Optimization Algorithms		Learning Activities

(schedule continued on next page)

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Module 2: Gradient-based and Classical Methods and Convex Optimization		
Lesson 3: Gradient-based and Classic Methods I	Due June 15, 2025 Assignment #2	Due June 12, 2025 Discussion #2
Lesson 4: Gradient-based and Classic Methods II		Midterm Exam Due June 15, 2025
Lesson 5: Convex Optimization Methods		Learning Activities
Module 3: Markov Chain, Reinforcement Learning, and Multi-Objective Optimization		
Lesson 6: Random Walk and Markov Chain	Due June 22, 2025 Assignment #3	Due June 19, 2025 Discussion #3
Lesson 7: Reinforcement Learning		Learning Activities
Lesson 8: Multiobjective Optimization		
Lesson 9: Genetic Algorithms	Due June 29, 2025 Assignment #4	Due June 26, 2025 Discussion #4
Lesson 10: Simulated Annealing		Due June 29, 2025 Final Exam
Lesson 11: Ant Colony Optimization		Learning Activities
Lesson 12: Particle Swarm Optimization		

Course Grading:
Course grading will be a combination of objective and subjective measurements to evaluate student performance based on homework, threaded discussion, exams or a project.

Discussion (25 points per module)	100
Homework (125 points per module)	500
Midterm Exam	200
Final Exam	200
Total Points	1000

When answering essay questions on homework or exams, it is OK to refer to course material and other reference materials, but it is NOT OK to substantially copy the wording from these materials. **Answers to essay questions and threaded discussion posts must be written in your own words**. If an instructor judges that the answer is worded substantially the same as in the course or reference material or as submitted by another student, it may be considered academic dishonesty and subject to consequences described in the university catalog. For example, if textbook material is copied and pasted into the answer to a homework or exam question, a score of zero will be given for that question and a warning will be issued by the instructor. Repeat offenses may result in a score of zero given for the entire exam/quiz/homework/discussion, reporting of the incident to the NU Judicial Affairs Office, and a failing grade in the class.

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Grades and Grading System:

A = 95-100%, A- = 90-94%, B+ = 87-89%, B = 84-86%,
B- = 80-83%, C+ = 77-79%, C = 74-76%, C- = 70-73%, D+ = 67-69%
D = 64%-66%, D- = 60-63%, F = < 60%

Grades that are in-between will be rounded up/down to the nearest whole number. For example, 94.4 and below will become 94%, while 94.5 and above will round up to 95%.

A	Outstanding Achievement
B	Commendable Achievement
C	Marginal Achievement
D	Unsatisfactory *
F	Failing *

* Student receiving this grade in a course that is required for his/her degree program must repeat the course.

I: **Incomplete:** A grade is given at the discretion of the instructor when a student has completed **at least two-thirds of the course class sessions** and is unable to complete the requirements of the course because of *uncontrollable* and *unforeseen* circumstances. The student must convey these circumstances (preferably in writing) to the instructor prior to the final day of the course. If an instructor decides that an "Incomplete" is warranted, the instructor must convey the conditions for removal of the "Incomplete" to the student in writing. A copy must also be placed on file with the Office of the Registrar until the "Incomplete" is removed or the time limit for removal has passed. An "Incomplete" is not assigned when the only way the student could make up the work would be to attend a major portion of the class when next offered.

An "I" that is not removed within the stipulated time becomes an "U." No grade points are assigned.

W: **Withdrawal**: Signifies that a student has withdrawn from a course after beginning the third class session. Students who wish to withdraw must notify their admissions advisor before the beginning of the sixth class session in the case of graduate courses. Instructors are not authorized to issue a "W" grade.

Threaded Discussion (25 points per module; 100 points total)

The educational goal of the threaded discussion is to give students an opportunity to reflect on the conceptual material and the class discussions and synthesize this knowledge into an understanding of the course learning objectives. The threaded discussion assignments will be graded based on **Quality of information** and **Delivery of Information**. For moderate performance levels, students need to answer the questions in detail AND respond to one other post. To receive maximum points in the high-performance levels, students should answer all the questions and respond in detail to at least two other posts.

Grading (On a scale of 0-25)	Quality of Information	Delivery of Information
0-10 points = Low performance	Post is not related to the assignment; irrelevant remarks are made; no response to other posts.	Poor spelling and grammar, "hasty" appearance, professional vocabulary not used, and attitude negative or indifferent.
10-20 points = Moderate performance	Post is related to the topic; supporting details or examples are not included in sufficient breadth or depth; the author simply restates concepts from others (textbook, instructor). One response to another post.	Few grammatical or spelling errors, a professional vocabulary used most of the time, and a positive attitude displayed frequently.
20-25 points = High performance	Supporting details and examples are both broad and deep; the author shows originality and does not just restate the textbook or instructor; multiple detailed responses to other posts.	Consistent grammatically correct posts with professional vocabulary, no misspellings, and a positive attitude displayed throughout.

Table: Points associated with performance levels.

Homework (125 points per module; 500 points total)
The educational goal of homework is to check the analysis and synthesis of the class material and its applications to analytical problem-solving. The homework must be completed and submitted by midnight on Sunday. Only submissions in Word or PDF will be accepted.

Please include your last name and the module number in the filename of your homework. For example: LastName_Module1 homework.pdf

Midterm and Final Exams (200 points each)
The educational goal of the quizzes and exams is to check understanding and synthesis of class material with classroom discussions and overall progress towards mastery of the Course Learning Objectives. Exams will be open notes, open books, and taken online through the course website. It is expected to take approximately 2 hours to complete the exams.

National University Policies and Procedures
Please see the current policies and procedures in the catalog (https://www.nu.edu/catalog) and the syllabus in the Brightspace course.