FLORIDA ATLANTIC UNIVERSITY

NEW COURSE PROPOSAL
Graduate Programs

UGPC Approval _____
UFS Approval _____
SCNS Submittal _____
Confirmed _____
Banner _____
Catalog _____

Department EECS

College ENG&CS

*(To obtain a course number, contact **erudolph@fau.edu**)*

Prefix COT **Number** 6455	*(L = Lab Course; C = Combined Lecture/Lab; add if appropriate)* **Lab Code**	**Type of Course** Lecture	**Course Title** Convex Optimization

Credits *(Review Provost Memorandum)*: 3

Effective Date *(TERM & YEAR)*: Spring 2023

Grading *(Select One Option)*: Regular (X) ; Sat/UnSat ( )

Course Description *(Syllabus must be attached; see Guidelines)*

The course introduces students the basic theory of optimization, including least-squares, linear and quadratic programs, semidefinite programming, minimax, optimality conditions and the duality theorem. Methods include steepest descent, conjugate gradient, and interior point methods are discussed in detail.

Prerequisites

None

Prerequisites, Corequisites and Registration Controls are enforced for all sections of course.

Academic Service Learning (ASL) course ☐

Academic Service Learning statement must be indicated in syllabus and approval attached to this form.

Corequisites

None

Registration Controls *(For example, Major, College, Level)*

Engineering or CS graduate standing or approval of instructor

Minimum qualifications needed to teach course:
Member of the FAU graduate faculty and has a terminal degree in the subject area (or a closely related field.)

List textbook information in syllabus or here

refer to attached syllabus

Faculty Contact/Email/Phone

rpashaie@fau.edu

List/Attach comments from departments affected by new course

Approved by	***Date***
Department Chair	8/24/2022
College Curriculum Chair	9/19/2022
College Dean	9/19/2022
UGPC Chair	Oct 13, 2022
UGC Chair	Oct 13, 2022
Graduate College Dean	
UFS President	
Provost	

Mihaela Cardei
Mihaela Cardei (Oct 13, 2022 10:51 EDT)

Email this form and syllabus to UGPC@fau.edu 10 days before the UGPC meeting.

COT 6455
Convex Optimization

TT 9:30 – 10:50
3 credits

Fall 2021
Prof. Ramin Pashaie
Office: EE 325
Office hours: MWF 11-12
Telephone: 561-297-1041
Email: rpashaie@fau.edu

Course Description
The course introduces students the basic theory of optimization, including least-squares, linear and quadratic programs, semidefinite programming, minimax, optimality conditions and the duality theorem. Methods include steepest descent, conjugate gradient, and interior point methods are discussed in detail.

Instructional Method
A brief statement about the Instructional Method and the expectations for student attendance in the class will be included here. For a list of the Instructional Methods and their definitions, see https://www.fau.edu/registrar/courses/Instru_Method.php

Prerequisites/Corequisites
None.

Course Objectives/Student Learning Outcomes
Optimization is an essential tool for students in science and engineering programs and many other disciplines including economy, finance, and operation research. The main objective of this course is to provide students an opportunity to learn the optimization theory based on the modern approach of Convex optimization. Students will receive training to cast problems in a form of convex programming and use iterative computer-based techniques to solve the problem and find optimal solutions of different problems. Many applications of the methods in signal processing, machine learning, data analysis, market evaluation and making optimal predictions or estimations will be discussed during lectures.
In summary, the course has three main objectives: 1. Recognize and formulate convex optimization problems that arise in applications, 2. Analyze a convex problem using convexity theory and duality theory, 3. Understand how to solve convex problems using numerical techniques and obtain some practice in solving them.

Course Evaluation Method

- There will be regular homework assignments. 8 homework assignments (4 before midterm exam and 4 between midterm and final exam). 30% of the final score.
- There will be an in class written midterm exam. 35% of the final score.
- There will be an in class written final exam. 35% of the final score.

Course Grading Scale

Grading Scale:

- 90 and above: A
- 87-89: A-
- 83-86: B+
- 80-82: B
- 77-79: B-
- 73-76: C+
- 70-72: C
- 67-69: C-
- 63-66: D+
- 60-62: D
- 55-59: D-
- 54 and below: F

Policy on Makeup Tests, Late Work, and Incompletes (if applicable)

No late homework will be accepted,
Students may not be penalized for absences due to participation in university-approved activities, including athletic or scholastics teams, musical and theatrical performances, religious observance, and debate activities. Such students will have time to make up missed work without any reduction in the final course grade.
Grades of Incomplete ("I") are reserved for students who are passing the course but have not completed all the required work because of exceptional circumstances.

Policy on the Recording of Lectures (optional)

- Students enrolled in this course may record video or audio of class lectures for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach students about a particular subject.
- Recording class activities other than class lectures, including but not limited to student presentations (whether individually or as part of a group), class discussion (except when incidental to and incorporated within a class lecture), and private conversations between students in the class or between a student and the lecturer, is prohibited.
- Recordings may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct and/or the Code of Academic Integrity.

Attendance Policy

Attendance is not required but strongly recommended.
Students are responsible for arranging to make up work missed because of legitimate class absence, such as illness, family emergencies, military obligation, court-imposed legal obligations

or participation in university-approved activities. Examples of University-approved reasons for absences include participating on an athletic or scholastic team, musical and theatrical performances and debate activities. It is the student's responsibility to give the instructor notice prior to any anticipated absences and within a reasonable amount of time after an unanticipated absence, ordinarily by the next scheduled class meeting. Instructors must allow each student who is absent for a University-approved reason the opportunity to make up work missed without any reduction in the student's final course grade as a direct result of such absence.

Counseling and Psychological Services (CAPS) Center

Life as a university student can be challenging physically, mentally and emotionally. Students who find stress negatively affecting their ability to achieve academic or personal goals may wish to consider utilizing FAU's Counseling and Psychological Services (CAPS) Center. CAPS provides FAU students a range of services – individual counseling, support meetings, and psychiatric services, to name a few – offered to help improve and maintain emotional well-being. For more information, go to *http://www.fau.edu/counseling/*

Disability Policy

In compliance with the Americans with Disabilities Act Amendments Act (ADAAA), students who require reasonable accommodations due to a disability to properly execute coursework must register with Student Accessibility Services (SAS) and follow all SAS procedures. SAS has offices across three of FAU's campuses – Boca Raton, Davie and Jupiter – however disability services are available for students on all campuses. For more information, please visit the SAS website at *www.fau.edu/sas/*.

Code of Academic Integrity

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high-quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see *University Regulation 4.001*.

Required Texts/Readings

Boyd and Vandenberghe, Convex Optimization, Cambridge University Press, 2004.

PDF of the textbook is available for free by the author.

Course Topical Outline

Week – 1 Introduction to optimization

- The Role of optimization, convexity
- Examples of application (communications, signal processing)

Week - 2 Review of linear algebra and mathematics background,

Week – 3,4,5 Convex set and convex function,

- Convex set, convex functions
- Operations that preserve convexity (both sets and functions)
- Conjugate function, conjugate sets
- Separating hyper-plane theorem

Week – 6, 7 Convex optimization problems

- Optimization problem definition and examples,
- Linear programming,
- Quadratic programming,
- Geometric programming,
- Semi-definite programming.

Week – 8,9 Duality,

- Lagrangian dual function (conjugate function)
- Lagrange dual problem
  I. Properties, weak and strong duality
  II. Interpretation of dual variables, duality (geometric, saddle point, economics)
- Optimality conditions
  I. KKT, necessity and sufficiency
  II. Sub-gradients for non-smooth functions
- Examples:
  I. Water-filling and reverse water-filling
  II. Multiple-access sum capacity (scalar or MIMO version)
  III. Compress sensing (using sub-gradient)

Week – 10,11,12,13 Methods and algorithms

- Unconstrained
  I. Gradient descent, steepest descent
  II. Newton method
- With equality constraints
  I. Newton methods with equality constraints
  II. ADMM method
  III. Sub-gradient method
- With inequality constraints
  I. Barrier interior point method
  II. Primal-dual interior point methods

Week – 14,15 Advanced topics,

- First-order methods for large-scale optimization,

I. First-order gradient descent,
II. Application in machine learning.

- Schur convexity

Signature: 

Email: rstackma@fau.edu

From: Hanqi Zhuang <zhuang@fau.edu>
Sent: Monday, November 21, 2022 7:13 PM
To: Stephen Locke <lockes@fau.edu>
Subject: Re: COT 6455 Convex Optimization

Steve,

Sure. If you propose any optimization course, we will endorse it.

Thank you,
Hanqi

From: Stephen Locke <lockes@fau.edu>
Sent: Monday, November 21, 2022 5:20 PM
To: Hanqi Zhuang <zhuang@fau.edu>
Subject: COT 6455 Convex Optimization

I have a few responses from the faculty I consulted. The course certainly overlaps topics we have covered in our department, and we reserve the right to teach those topics in the future. That said, we have no further objection to the course, COT 6455 Convex Optimization, proposed by your department.

Stephen

S.C. Locke, Professor and Chair,
Math. Sci. Dept.