CSC 4512
Optimization Approaches in Computer Science: Algorithms and Applications

SPRING 2025

Louisiana State University
School of Electrical Engineering and Computer Science
Division of Computer Science and Engineering

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Webpage: **http://www.csc.lsu.edu/trianta**
Classroom: 1212 Patrick Taylor Hall
Meeting Times: Tuesday & Thursday: from 3:00 to 4:20 p.m.
Office hours: By appointment only. Use my yahoo.com email address given above to contact me.

The Teaching Assistant (TA) is **to be announced.**

Textbook: Operations Research: An Introduction, by Hamdy A. Taha, **any Edition is OK**. Prentice Hall. Plus, materials to be announced during the lectures (such as handouts, and/or URLs). **Any new material covered in lectures must be read from the textbook / handouts <u>all the time</u>.**

Brief Course Description:
Three credit hours.

This course focuses on one of the most powerful modeling tools available today, namely, on optimization. A very high number and incredible variety of problems in the sciences, engineering, and especially in computer science and IT (information technology) can be formulated as optimization problems. For instance, if one searches the US Patent and Trademark Office (http://patft.uspto.gov/netahtml/PTO/index.html) under key phrases such as "optimization Google", "optimization Facebook", "optimization Microsoft", etc., then large numbers of patents which directly involve optimization will be presented.

This course is organized into three parts. The first part illustrates the richness of optimization by discussing some basic optimization formulations. The second part emphasizes some fundamental theoretical and algorithmic developments in this area. Emphasis is given on linear programming (LP) approaches. Finally, the third part focuses on some optimization approaches which are based on non-linear models. All the developments are presented in an intuitive and logical manner and special emphasis is given on the foundations of optimization theory, algorithms, and applications.

<u>Prerequisite:</u> A course (such as MATH 2090) discussing the basic concepts of linear algebra is needed.

GOALS:

This course is an excellent educational experience for any student who wishes to gain a proficiency in formulating a wide spectrum of key problems by means of optimization modeling. It provides valuable experience to those who wish to master the art and science of practical problem modeling and solving and also for those who wish to acquire a deep understanding of the various theoretical and algorithmic issues involved. Both graduate and undergraduate students in computer science, engineering, sciences and business are excellently suitable for this course.

MAIN TOPICS (Based on a 14-week plan. The numbers are approximate):

Week #1: Introduction remarks. The grading policy and related issues. What is the general form of an optimization problem? The LP (linear programming) model. The IP (integer programming) model. Other optimization models (linear vs. non-linear programming).

Part 1: The Typical LP Optimization Problem. Model Formulation Issues
Weeks #2 - #3: Formulation of the typical LP optimization (i.e., the optimal mix) problem

Part 2: Algorithms and Solution Approaches
Weeks #4 - #5: Solving 2-Dimensional LP problems
Week #6: The importance of convexity in optimization
Week #7: Solving LPs with more than 2 variables
Week #8: The KKT conditions
Week #9: Solving a special type of LPs: The transportation problem (TP)
Week #10: Solving a special type of LPs: The assignment problem (AP)

Part 3: Approaches for Solving Some Non-Linear or Special Types of Problems
Week #11: Solving Integer Programming (IP) problems. The branch & bound (B&B) approach.
Week #12: Unconstrained non-linear problems using the steepest ascent / descent approach.
Week #13: Solving a special type of LPs: The maximum flow problem.
Week #14: Solving the shortest route problem.

GRADING:

Homework assignments:	25%. Some HWs may be worth twice the points and be given extra time to complete (will be like small projects). **NOTE:** The last HW will be due during the study concentration period (i.e., **<u>by May 4, 2025</u>**).
2 Midterm Exams:	40% **with CLOSED books / notes / and no gadgets. No toilet breaks either.** Each one of the two midterm exams is worth 20%. Each midterm exam will **be comprehensive up to the date before it** (i.e., it will cover everything from the first day until the last lecture before it).
A Final Exam:	35% **with CLOSED books / notes / and no gadgets. No toilet breaks either. It covers EVERYTHING since first day.**
Total points:	**100** **<u>NOTE: No grade curving will be implemented.</u>**

NOTE: If you have to miss an exam (midterm or final) you must inform the instructor PRIOR to the exam via email. Furthermore, you must provide ASAP adequately documented support on the reason and do so promptly. Otherwise, a zero grade will be assigned automatically for the missed exam.

COMMENTS:

[1]: **The Grading Scale is as follows:**

SCORE	GRADE
100, 99, 98	A+
97, 96, 95, 94, 93	A
92, 91, 90	A-
89, 88, 87	B+
86, 85, 84, 83	B
82, 81, 80	B-
79, 78, 77	C+
76, 75, 74, 73	C
72, 71, 70	C-
69, 68, 67	D+
66, 65, 64, 63	D
62, 61, 60	D-
59, or less	F

An F grade (Fail) will be earned for 59 or fewer points. Note that a D grade is not a passing grade for graduate students.

[2]: The instructor's presentations will be highly interactive. The presentations aim to maximize audience engagement and are based on material presented during the lectures. Therefore, class attendance and active participation are **<u>strongly</u>** encouraged (but are **<u>not</u>** considered for the grade).
Always feel free to ask any questions you wish during the lectures.

[3]: **Some key dates for our course are as follows:**
(Based on LSU's Academic Calendar for 2024-2025)

January 14, 2025,	Tuesday:	Our first class	
20, 2025	Monday:	Dr. Martin Luther King Day Holiday	
22, 2025,	Wednesday:	Final date for dropping courses without receiving "W"	
23, 2025,	Thursday:	Final date for adding courses for credit	
March 4, 2025,	Tuesday:	Mardi Gras Holiday (no class)	
7, 2025,	Friday:	Mid-semester grades are due, 9:00 a.m.	
24, 2025,	Monday:	Course scheduling for fall semester 2025 begins	
28, 2025,	Friday:	Final date for dropping courses	
March 31- **April 4,** 2025 (one week):		Spring Break 2025	
April 18, 2025,	Friday:	Good Friday 2025	
30 – **May 4**, 2025 (one week):		Concentrated study period	
May 1, 2025,	Thursday:	Our last class	
5 – 10, 2025	Saturday:	Final Exams week	
5, 2025	Monday:	Our final exam (in class). 3:00 – 5:00 p.m.	
13 – 14, 2025	Tue – Wed:	Final grades are due	
16 – 17, 2025,	Fri – Sat:	Commencement Days	

Policy Statement Regarding Cheating / Academic Misconduct

A student caught cheating, plagiarizing, or violating <u>any of the guidelines</u> described in this Policy Statement will be reported as a case of academic misconduct to the Dean of the Office of Student Advocacy and Accountability (SAA) at LSU.

LSU's Code of Student Conduct, Section 10.1 Academic Misconduct, governs all the work in this course (please check all the materials at: **https://www.lsu.edu/saa/students/codeofconduct.php**). Unless indicated otherwise, all written work that is handed in must be done only by the individual whose name appears on the document. Regarding student cooperation on the homework assignments, you are encouraged to discuss with other students the homework problems in general terms; however, what you submit must be your own answers. Your instructor and teaching assistant(s) (if TAs have been assigned to this course) are authorized and best qualified to give you help on all work (help will not be given if it provides an unfair advantage). Students are strongly encouraged to carefully study the contents of LSU's Code of Student Conduct on plagiarism and other related issues of academic misconduct. **<u>Thus, you are strongly advised to visit the website of LSU's Office of Student Advocacy and Accountability (SAA) at:</u> https://www.lsu.edu/saa/**

For specific information on LSU's definition of **what constitutes academic misconduct**, please visit the following website: **https://www.lsu.edu/deanofstudents/files/lsu-code-of-conduct.pdf**

For some other related concepts of what constitutes plagiarism, visit the following website:
http://homeworktips.about.com/od/citationsandbibliography/a/What-Is-Plagiarism.htm

While you are doing your assignments, **if you use material created by others and is found on the web, you must indicate so clearly.** You must list the source of that material and clearly show which part of your assignment is based on such material from the Web. **<u>Failure to do so will be considered academic misconduct and will be reported.</u>**

In summary, if you use a source from the literature make sure you cite it properly. If you use a segment already published in the literature, make sure you clearly indicate so by providing the source and use that segment within "quotes" and a different font type.

Should you have any questions / doubts, etc., please contact me at once via email (i.e., in writing, <u>no verbal communication</u>) BEFORE you submit your assignment.

1) *Make sure that you understand a given problem before you attempt to answer it. Carefully review the theory covered. Do so by checking the lecture recording (if available), your notes, and ALWAYS read the textbook.*

2) *You must solve **all** the problems in a given HW or project by **YOURSELF**.*

3) *Pay extra attention in the **organization** of your answers. Solutions should not be mixed up with scratch material in deriving them.*

4) *Present and staple your solutions **sequentially**. Scan them by using a scanner or create a PDF file otherwise if possible (no photos please!) and submit them via Moodle.*

5) *Make sure that your English is correct, clear and easy to read. Although this is not a composition course, it is very important that you present your solutions in a highly professional and scientific manner.*

6) *If you get confused, do not worry. Just relax, organize your thoughts, and try to see the problem from a simple, but still accurate, point of view.*

7) *You should have no doubt that **you** (assuming you have studied adequately) are capable of answering all the problems in the HWs and projects!*

A hint...

Next is the first problem which would have been given to you in the midterm and final exams (**but we will do not have such exams this time**) along with the correct answer. It is usually assigned 5 points.

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PROBLEM 1: (5 points)

What is the single most important step in solving any science / engineering problem?

Answer: To define the problem **correctly** and **enjoy** the solution process.

(You must underline the right words to earn all 5 points.)