IEE 376 - Operations Research Deterministic Techniques and Applications
Ira A. Fulton Schools of Engineering
School of Computing, Informatics, and Decision Systems Engineering (CIDSE)
Instructor: Jorge A. Sefair (jorge.sefair@asu.edu)
M W 6:00 PM – 7:15 PM, Tempe CAVC 351 — **Fall 2018**
Updated: Thursday 20th September, 2018, 22:31

Motivation: *"Optimization is everywhere. It is human nature to seek the best option among all that are available. Nature, too, seems to be guided by optimization – many laws of nature have a variational character"* (Güler, 2010).

Course description: In this introductory course on deterministic Operations Research (OR), we will formulate mathematical models and develop solution methods for decision making. We will study how to obtain the best decisions to improve real-life problem situations, according to well-defined objectives. Although many problem classes will be studied, the course will focus on problems that can be modeled as linear programming models. Formally, a linear programming model is either a minimization or maximization of a linear function of several variables constrained by linear inequalities. We will study applications in a variety of domains, including transportation, health care, finance, and manufacturing. The theoretical foundation will include the simplex algorithm, theorems of duality, sensitivity analysis, network flows, and basic integer programming.

Prerequisites: Students are expected to have a good background in linear algebra and some knowledge of a programming language (C++, Matlab, Java, Python). That is: CSE 205 with C or better; MAT 242, 342 or 343 with C or better; or Industrial Engineering graduate student (MS or PhD).

Course objectives: At the end of this course, students are expected to be able to: (1) identify situations where optimization can improve the decision-making process, (2) mathematically formulate optimization problems, (3) implement and solve optimization problems using commercial software, and (4) analyze, interpret, and communicate the output of an optimization problem to professionals in other disciplines.

Textbook:
- [HL] Introduction to Operations Research, 10th ed. 2014. F.S. Hillier and G.J. Lieberman. McGraw-Hill.

Additional reading:
- [FGK] AMPL: A Modeling Language For Mathematical Programming, 2nd ed. 2002. R. Fourer, D.M. Gay, and B.W. Kernighan. Cengage Learning. URL: http://ampl.com/resources/the-ampl-book/

Optimization Software:
- AMPL. Unrestricted version available in Blackboard (Linux, macOS 64, Windows 32 and 64). Linear and nonlinear state-of-the-art solvers (Baron, Knitro, Cplex, Gurobi)

Instructor:
- Contact: jorge.sefair@asu.edu – Office hours: M W 4:20 - 5:45 PM (BYENG 210) (email me in advance).

Teaching Assistant:
- Name: Romena Yasmin – Contact: ryasmin@asu.edu – Office hours: T Th 12:00 - 1:00 PM, location: BYENG 221

Grading: Homework (×4): 20% – Exam 1: 25% (October 3) – Exam 2: 25% (November 14) – Final Exam: 30% (December 5, 4:50 - 6:40 PM)

Exams rules: Exams are comprehensive and closed book, closed notes, no cheat sheets, no calculator. There will be no make up exams. In the event of a university-approved absence on an exam day, the final exam grade will be used as a substitute for the missed exam. Notify the instructor ahead of time, whenever possible.

Homework: There are four homework assignments which will allow you to practice the concepts learned in the class, and will include modeling, coding, and mathematical problems. Homeworks can be solved in groups of **no more than three students, no exceptions**. Collaboration between groups is **not allowed**.

Honors Enrichment Contracts: Contact the instructor for details.

Letter Grade Distribution:

Final average	Grade	Final average	Grade	Final average	Grade	Final average	Grade
> 100.00	A+	$[85, 90)$	B+	$[70, 75)$	C+	< 55	E
$[95, 100)$	A	$[80, 85)$	B	$[65, 70)$	C		
$[90, 95)$	A-	$[75, 80)$	B-	$[55, 65)$	D		

Course Outline (tentative):

Chapter	Topics	Reading
Motivation	Introduction to the course, impact of OR, selected optimization problems, in-class activity.	§1.1–1.4 [HL]
Formulation of optimization problems	Basic definitions, classification of optimization problems	§2 [HL]
	Graphical solution method	§3.1 [HL]
	Large-scale formulations, canonical and standard forms	§3.2, Table 5.3 [HL]
	Introduction to optimization modeling	§3.4 [HL]
	Common modeling structures: types of constraints, objective functions, and decision variables	
	Modeling practice (with AMPL)	§4 [FJK]
Linear optimization	Basic concepts, global and local optima, improving search paradigm	
	Assumptions of linear programming, slack variable, binding constraint, polyhedron, extreme point, direction of a set, extreme directions, recession cone	§3.3, 4.1, 5.1 [HL]
	Geometry of linear programming, basis, basic solution, basic and non-basic variables, moving along extreme points	§4.2, 5.2 [HL]
	Simplex method: Basic feasible initial solution, optimality test, direction of movement, minimum ratio test, pivoting	§4.3, 5.2 [HL]
	Simplex method in tabular form	§4.4, 5.2 [HL]
	Simplex method: Initialization	§4.6 [HL]
Duality and sensitivity analysis	Motivation, dual and primal problems, dual interpretation	§6.1, 6.4
	Duality theorems, primal-dual relationship	§6.2, 6.3 [HL]
	Sensitivity analysis, changes in right-hand-side, objective function coefficients, adding/removing a variable, adding/removing a constraint	§6.5, 7.1-7.3 [HL]
Introduction to network optimization	Notation, definitions, selected applications, minimum cost flow problem	§10.1, 10.6 [HL]
	Shortest path, maximum flow, transportation, and assignment problems	§10.3, 10.5, 9.1, 9.3 [HL]
Introduction to integer programming	Motivation, modeling structures, applications, modeling practice	§12.1-12.4 [HL]
	Branch-and-bound	§12.7 [HL]

Course Policies:

- **Communications:** All the course-related materials will be available in Blackboard.

- **Class Attendance and Participation:** Student attendance is encouraged and active participation is expected. Accommodations will be made for religious observances provided that students notify the instructor at the beginning of the semester concerning those dates. Students who expect to miss class due to officially university-sanctioned activities should inform the instructor early in the semester. Alternative arrangements will generally be made for any examinations and other graded in-class work affected by such absences. The preceding policies are based on ACD 30404[1], "Accommodation for Religious Practices" and ACD 30402[2], "Missed Classes Due to University-Sanctioned Activities." For the ASU Academic Affairs Manual, see: http://www.asu.edu/aad/manuals/acd/index.html.

- **Academic Integrity:** All students in this class are subject to ASUs Academic Integrity Policy[3] and should acquaint themselves with its content and requirements, including a strict prohibition against plagiarism. All

---

[1]Available at: https://www.asu.edu/aad/manuals/acd/acd304-04.html

[2]Available at: https://www.asu.edu/aad/manuals/acd/acd304-02.html

[3]Available at: http://provost.asu.edu/academicintegrity

violations will be reported to the Deans office, who maintain records of all offenses. Students are expected to abide by the FSE Honor Code[4]. "Each student must act with honesty and integrity, and must respect the rights of others in carrying out all academic assignments." Failure to meet these standards may result in a reduction in assignment grade, reduction in course grade, suspension or expulsion from the university, or other sanctions consistent with the university policy and the Student Code of Conduct[5]. This course will follow the ethical standards of ASU at large. Plagiarism, cheating, and dishonesty will not be tolerated.

• **Grade Corrections:** A student may submit a written request for a homework or exam grade to be reviewed within one week after the grade is posted in Blackboard. Note that Obligation 14 in the Student Academic Integrity Policy reads "Attempts to influence or change any Academic Evaluation, assignment or academic record for reasons having no relevance to academic achievement." In other words, asking an instructor to change your grade because you need a higher grade to keep a scholarship, maintain athletic eligibility, get off academic probation, or for any reason not relevant to your academic achievement in this class is a violation of the Academic Integrity Policy.

• **Title IX:** Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs. As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence.

• **Counseling Services:** ASU provides confidential and private counseling services for students experiencing emotional concerns, problems in adjusting, and other factors that affect their ability to achieve their academic and personal goals. You can find information and resources at https://eoss.asu.edu/counseling.

• **CIDSE Advising Services:** Information about instructional concerns and course-related complaints is available at: http://cidse.engineering.asu.edu/wp-content/uploads/2011/11/Undergraduate-Instructional-Concerns.pdf.

• **Students with Disabilities:** Suitable accommodations will be made for students having disabilities and students should notify the instructor as early as possible if they will require same. Such students must be registered with the Disability Resource Center and provide documentation to that effect. More information about the ASU DRC can be found at: http://eoss.asu.edu/drc

• **Threatening or Disruptive Behavior:** We will follow the ASU Student Services Manual (SSM 104–02)[6] if there are any cases of disruptive, threatening, or violent behavior that arise. Individuals can be asked to leave the premises, or the police may be called in an extreme situation.

• **Copyrighted Course Material:** The course content, including lectures, is copyrighted material. Furthermore, in accordance with ACD 304–06[7] of the ASU Academic Affairs Manual, students may not sell notes taken during the conduct of the course without the express written permission of the instructor.

• **Classroom Etiquette:** In order to assure an environment that promotes learning for everyone present, cell phones and pagers must be turned off during class to avoid causing distractions. The use of recording devices is not permitted during class. Any violent or threatening conduct by an ASU student in this class will be reported to the ASU Police Department and the Office of the Dean of Students.

• **The information in the syllabus, other than grade and absence policies, may be subject to change with reasonable advanced notice.**

Updated: Thursday 20th September, 2018, 22:31

---

[4]Available at: http://engineering.asu.edu/integrity/

[5]The ASU Student Code of Contact: http://eoss.asu.edu/dos/srr/codeofconduct

[6]The ASU policy on handling of disruptive/threatening/violent individuals on campus: http://www.asu.edu/aad/manuals/ssm/ssm104-02.html

[7]ACD 304–06, Commercial Note-Taking Services: http://www.asu.edu/aad/manuals/acd/acd304-06.html