Math 364: Principles of Optimization
Spring 2019

Time	Tue,Thu 2:50–4:05 pm
Location	VLIB 260
Instructor	Bala Krishnamoorthy
Office	VUB 347
Office Hours	Tue 1:30–2:30 PM, Wed 10:30–11:30 AM
Email, Phone	kbala@wsu.edu, 360-546 9167
Course web page	http://www.wsu.edu/~kbala/Math364
Prerequisites	Intro. Linear Algebra (Math220/equivalent); or permission of instructor
Book	**Lecture notes and handouts**
References	W.L. Winston and M. Venkataramanan — Introduction to Mathematical Programming, Fourth edition. Thomson Brooks/Cole, ISBN: 0-534-35964-7

Description of the Course: Optimization is applied to model and solve problems from business, engineering, sciences, sports, and several other areas. This course will give a full introduction to linear optimization, and a short introduction to integer linear optimization. Emphasis will be given to model formulation, basic concepts behind solution techniques and algorithms, and to the use of modeling software. Topics covered will include linear programming formulations, the simplex algorithm, duality, and integer programming formulations. The software AMPL will be introduced. Students will learn how to create models using this tool and to interpret the solutions.

Target Audience and Outcomes. A basic background in linear algebra will be required to follow the contents of the course. Typical audience is junior or senior undergraduate students. But the course is also suitable for graduate students, especially from disciplines other than Mathematics, who are looking to learn the basics of optimization. Students successfully completing this course would have command over formulating optimization problems involving linear functions and linear constraints, as well as integer restrictions on variables. They would have an understanding of the mathematics and computational techniques used to solve these problems. They would also be comfortable in the use of standard software packages for solving real life instances of such problems.

Organization and Grading: Around eleven (11) homework assignments will be given. Each assignment will be handed out at least one week before the day on which it will be due (dates are given in the tentative schedule). It is very important to work sincerely on the homework problems if you want to do well in this course. **Homework should be handed in at the beginning of class on the day it is due. Late homework will NOT be accepted.**

There will be a **project**, for which you will work with real(ish) data. I will propose one or two potential project topics, but you are welcome to pick your own topic after discussing the same with me. In fact, you are encouraged to explore your own options.

We will not follow a single textbook. Notes from the lectures will be posted on the course web page, and they will constitute the main resource for the class. I encourage you not to miss any of the lectures. Following the material covered in class is very important to do well in the homework assignments and in the exams.

There will be one mid-term and a final exam. The mid-term will be an in-class, closed-book exam. The final exam will be an in-class, open-book exam. The final will be cumulative, but will concentrate more on the topics covered after the mid-term. The total score for the course will be calculated using the following weights.

homework	45%
project	15%
mid-term	20%
final exam	20%

The least homework grade **from among the homework assignments submitted** will be dropped. No predetermined grade cut-offs are set for this course. I intend to curve the overall scores for the course in order to assign the final grades.

Software: The modeling software AMPL will be introduced. You are encouraged to **download and install the free (demo) version of AMPL from http://www.ampl.com**. You could run AMPL on most any computer you have access to (in particular, you do not need a powerful or fast machine, and you will not be required to have access to any other proprietary software). Necessary documentation will be provided in the form of class handouts. Also, all chapters from the book on AMPL are available from the above web page (for free).

Academic Integrity: Academic integrity is the cornerstone of higher education. As such, all members of the university community share responsibility for maintaining and promoting the principles of integrity in all activities, including academic integrity and honest scholarship. Academic integrity will be strongly enforced in this course. Students who violate WSU's Academic Integrity Policy (identified in Washington Administrative Code (WAC) 504-26-010(3) and -404) will receive a zero grade for the graded item and possibly a failing grade for the entire course, will not have the option to withdraw from the course pending an appeal, and will be reported to the Office of Student Conduct.

Cheating includes, but is not limited to, plagiarism and unauthorized collaboration as defined in the Standards of Conduct for Students, WAC 504-26-010(3). You need to read and understand all of the definitions of cheating (see http://app.leg.wa.gov/WAC/default.aspx?cite=504-26-010). If you have any questions about what is and is not allowed in this course, you should ask me before proceeding.

If you wish to appeal my decision relating to academic integrity, please use the form available at conduct.wsu.edu.

Discussion of homework problems with others is allowed, and is also encouraged. But each person should submit their own written solutions. You might search the internet or books for materials to enhance your understanding. If you use such material to assist in your homework or project submission, you **should** cite the relevant sources. Plagiarism or cheating will **not** be tolerated. In particular, do not copy blindly from internet sources. I can spot such instances easily!

Students with Disabilities: Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call your campus resource to schedule an appointment. All accommodations **MUST** be approved through the campus resource. For more information contact a Disability Specialist (at 360-546-9138; see http://studentaffairs.vancouver.wsu.edu/student-resource-center/disability-services).

WSU Safety Measures: Classroom and campus safety are of paramount importance at Washington State University, and are the shared responsibility of the entire campus population. WSU urges students to follow the "Alert, Assess, Act," protocol for all types of emergencies and the

''Run, Hide, Fight" response for an active shooter incident. Remain ALERT (through direct observation or emergency notification), ASSESS your specific situation, and ACT in the most appropriate way to assure your own safety (and the safety of others if you are able).

Please sign up for emergency alerts on your account at MyWSU. For more information on this subject, campus safety, and related topics, please view the FBI's Run, Hide, Fight video and visit the WSU safety portal.

Tentative Schedule

Week	Lec #	Date	Details
1	1	Tue, Jan 8	intro and example; review of linear algebra
	2	Thu, Jan 10	review of linear algebra
2	3	Tue, Jan 15	intro to linear programming (LP)
	4	Thu, Jan 17	2 var problem, graphical solution **[HW 1 Due]**
3	5	Tue, Jan 22	special cases, LP formulations
	6	Thu, Jan 24	LP formulations **[HW 2 Due]**
4	7	Tue, Jan 20	intro to AMPL
	8	Thu, Jan 31	LP standard form **[HW 3 Due]**
5	9	Tue, Feb 5	simplex algo
	10	Thu, Feb 7	simplex algo **[HW 4 Due]**
6	11	Tue, Feb 12	alternate optima, unbounded LPs
	12	Thu, Feb 14	big-M method **[HW 5 Due]**
7	13	Tue, Feb 19	big-M method
	14	Thu, Feb 21	review for midterm **[HW 6 Due]**
8	15	Tue, Feb 26	**Midterm (in class)**
	16	Thu, Feb 28	AMPL session
9	17	Tue, Mar 5	sensitivity analysis
	18	Thu, Mar 7	sensitivity analysis in matrix form
10		Tue, Mar 12	*Spring break*
		Thu, Mar 14	*Spring break*
11	19	Tue, Mar 19	dual of an LP
	20	Thu, Mar 21	duality, primal-dual relationships **[HW 7 Due]**
12	21	Tue, Mar 26	dual theorem, economic interpretation
	22	Thu, Mar 28	complimentary slackness **[HW 8 Due]**
13	23	Tue, Apr 2	complimentary slackness
	24	Thu, Apr 4	integer programming (IP) **[HW 9 Due]**
14	25	Tue, Apr 9	IP formulations
	26	Thu, Apr 11	IP formulations **[HW 10 Due]**
15	27	Tue, Apr 16	more IP formulations
	28	Thu, Apr 18	IP solution techniques, IP in AMPL **[HW 11 Due]**
16	29	Tue, Apr 23	More on LP/IP
	30	Thu, Apr 25	review for final **[Project due]**
17		Thu, May 2	**Final exam (2–4 PM)**