Math 364 – Principles of Optimization – Fall 2017

This syllabus is subject to change at the discretion of the instructor.

Website:	www.math.wsu.edu/faculty/tasaki/Classes/Math364
Times:	TuTh 10:35 – 11:50
Location:	CUE 409
Instructor:	Tom Asaki (tasaki@wsu.edu), Neill 228
Office Hours:	W 11–12, Th 12–2, and by appointment
Optional Texts:	Understanding and Using Linear Programming *Marousek and Gartner* Introduction to Mathematical Programming *Winston and Venkataramanan* An Illustrated Guide to Linear Programming *Saul I. Gass*

Description

Optimization techniques are applied to model and solve problems from business, engineering, sciences, sports, and many other areas. This course will give an introduction to nonlinear, linear and integer programming optimization methods. Emphasis will be given to: model formulation; solution methods; geometric and mathematical interpretations; basic theoretical results and concepts; sensitivity analysis; and software implementation. Examples, formulations, descriptions, derivations, and clarifications will be provided using class activities, lectures and other provided materials. I encourage you to attend all classes, both for the benefit of your grade and your understanding.

Prerequisites

Students should have completed a first course in linear algebra as this is the language of linear programming and other topics in optimization. Specific review topics include

1. Parametric solutions of systems of linear equations.
2. Geometric interpretation of solution sets of systems of linear equations.
3. Matrix and vector arithmetic.
4. Inner product (dot product).

5. Linear independence.
6. Invertible matrix theorem.
7. Matrix equation representations.

Course Skills

This course will emphasize the following theoretical, applied and compuational mathematical skills. The student will:

1. Understand the basic theory and practice of finding extremal points of smooth functions on both constrained and unconstrained domains.
2. Accurately sketch and describe representative level sets of functions of one to three variables and solution sets of systems of linear (in)equalities.
3. Accurately represent a general mixed integer program (MIP) in standard mathematical notation.
4. Understand the principles of solving MIPs and apply them to graphical solutions of low-dimensional examples.
5. Demonstrate MIP modeling skills using realistic problems.
6. Solve general MIPs using Octave or other appropriate software.
7. Understand the practice and geometry of the Simplex Method and apply use it to solve linear programs.
8. Perform and interpret sensitivity analysis on solutions to linear programs.
9. Understand and apply methods for solving integer programs including implicit enumeration, branch and bound, and cutting planes.
10. Understand the concepts of interior point methods for solving linear programs.

Grade Basis

Your grade will be based on the instructor's assessment of your mastery of course skills. The assessment will be based on classwork, homework, midterm exams and a project. Each student will be assigned a score for each of five equally-weighted course components. (Also see the section on the Attendance Policy.)

- (20%) Classwork and Homework
- (20%) Midterm Exam #1
- (20%) Midterm Exam #2

- (20%) Midterm Exam #3
- (20%) Project

Leter grades will be assigned according to the following scale based on total weighted score S.

- A : $90 \leq S$
- B+ : $86 \leq S < 90$
- B : $80 \leq S < 86$
- C+ : $76 \leq S < 80$
- C : $70 \leq S < 76$
- D : $60 \leq S < 70$
- F : $S < 60$

Classwork

Class time will involve a mix of interactive lecture and classroom activities. Some group work is to be expected. Activities will often include graded assignments and quizzes. I am counting on your willingness to both fail and succeed, to ask questions, to conjecture, to generalize.

The specific topics covered during any given class or week depends upon both our rate of progress through material and our actual path through the material. This course is somewhat dynamic in that we have some freedom to explore certain topics as they become relevant. However, a rough outline can be taken from the course skills outline above.

Homework

Homework will be assigned and collected periodically. For each problem, your task is to provide a solution – a process of attaining the answer that demonstrates that you understand the concepts discussed in class – not simply an answer. Grading is based on the following expectations.

```
90-100 : mastery of nearly all key concepts
         exceptional clarity of presentation and reasoning
80-89  : mastery of most key concepts
         good clarity of presentation and reasoning
70-79  : mastery of majority of key concepts
```

```
          reasonable clarity of presentation and reasoning
60-69   : mastery of few key concepts
          inadequate clarity of presentation and reasoning
```

These requirements take some students by surprise, especially the expectations on presentation and reasoning. Simply being able to attain a correct answer is *not* sufficient. Feel free to discuss your work with anyone, but I expect you to compose your own solutions. No late homework will be accepted.

Several homework problems will also require finding solutions using freely available software. Instructions for using online software will be provided.

Exams

Three midterm exams will be given in-class on days to be determined by our progress through the material. Exam #1 will cover course skills topics 1–4 as well as linear algebra review topics. Exam #2 will cover course skills topics 5–7. Exam #3 will cover course skills topics 8-10. Expect these exams to occur approximately in weeks 5, 10 and 15.

No makeup exams will be given except in cases of documented reasonable extenuating circumstances as determined by the instructor. Prior arrangements must be made between the student and instructor whenever possible.

You are allowed free use of personal notes, homework assignments, and any other notes supplied by me. You are not allowed to use a computer or any other electronic device except a calculator for performing arithmetic. The exam questions will be derived from classowrk, homework, lectures, and any assigned reading. They are designed to test your ability to apply concepts and methods both to familiar situations and to similar but new situations.

Exam expectations are not the same as the rigorous homework expectations. Some exam questions will simply require answers (as opposed to complete solutions) and some will specifically ask for reasoning. The exams will *not* require the use of a computer or software.

Project

The final examination for the course will be the completion of a research and/or software implementation project. I encourage projects which impact other personal areas of study or mathematical interest. The project must involve modeling and software implementation using freely available LP/IP solvers. On or before November 3 you must: first briefly discuss the idea with me, then provide a one page

proposal/synopsis, and finally meet with me to obtain my approval and agree on requirements. A variety of example project plans will be made available to assist you in creating and crafting your own project.

During the two final class days (December 5 and 7) the class activity will be 5-10 minute project presentations delivered by each student to their classmates. This presentation should contain the following elements: concise description, personal motivation, goals and expectations, aproach and methods, current status. Projects need not be complete in order to complete the presentation. Presentations will be graded on communication clarity, attention to required elements, and adherence to time limits. Presentations will not be graded on project completeness or formality of presentation. Questions from the audience are encouraged.

Project writeups are due before December 13 at 5:00 PM. Time extensions will not be granted. The student is encouraged to finish their project as early as possible.

Attendance Policy

From August 22 through November 30, no formal attendance policy is in force. However, missing graded class activities (and exams!) will impact your grade.

Attendance during presenation week (December 5 and 7) is required. For each missed day this week, your grade score (see section on Grade Basis) will be reduced by 5%.

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 WSUs Academic Integrity Policy (identified in Washington Administrative Code (WAC) 504-26-010(3) and -404) will receive a course grade of F, 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. If you have any questions about what is and is not allowed in this course, you should ask course instructors before proceeding. If you wish to appeal a faculty member's decision relating to academic integrity, please use the form available at conduct.wsu.edu.

Academic integrity includes the expectation that students avoid mathematical plagiarism. It is expected that students emulate the procedues and ideas formulated as a result of the classroom and study experience. However, copying or paraphrasing anothers work is not acceptable. Your work should demonstrate your *own* understanding. This means that you may need to include citations of other people's work or ideas.

```
Plagiarism: the practice of taking someone else's work or ideas and
passing them off as one's own; to use the words or ideas of another
person as if they were your own words or ideas.
```

The guiding principle: Your work should be an honest represenation of what you understand, and what you do not understand, about the course concepts.

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 FBIs Run, Hide, Fight video and visit the WSU safety portal.

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 the Access Center to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center or Disability Services. For more information contact a Disability Specialist: 509-335-3417, Washington Building 217; Access Center Website, Access.Center@wsu.edu