Instructor: Dr. Chris Lee Trexler 270D clee@roanoke.edu (540) 375-2347

Office Hours: I am available for office hours: Mon/Wed: 1:00 – 3:00pm Tue/Thu: 3:00-4:30pm
All office hours are by appointment. To make an appointment, please use the link:
https://drchrislee.youcanbook.me/

Learning Outcomes:

Students will be able to

- Understand and use the main models and methods of mathematical programming.
- Formulate practical problems into mathematical programming models.
- Recognize applied problems that can be studied using mathematical programming.
- Use software tools to solve mathematical programming models.
- Interpret the solutions to mathematical programming models to make good decisions.

Course Description: This course provides an introduction to Operations Research: a mathematical approach to decision making based on optimization. Topics include the simplex method, sensitivity analysis, duality, transportation problems, and network models.

Prerequisite: Enrollment in this course requires successful completion of Math 201 Linear Algebra.

Text: *Operations Research: Applications and Algorithms.* Winston, 4th Ed.

Attendance: Attendance is critical to the understanding of the material in the course; it is both required and expected. Any absence that is not discussed with the instructor prior to the missed class is considered unexcused. I will assume that if you accumulate 3 unexcused absences you are not interested in completing the course and will drop you from the class with a grade of DF (dropped-failing) recorded, regardless of your current average in the course. You, your advisor, and the registrar will receive a warning email at your second unexcused absence. When absent, excused or unexcused, you are responsible for all material covered in class. Work missed due to either an unexcused or excused absence can only be made up when arrangements are made in advance of the absence.

Late Work: Unless specific permission is given in advance of the due date, no late work will be accepted.

Reading and Participation: The key to learning a topic in mathematics is participation. We will strive to have an active, rather than passive, classroom environment. The last page of the syllabus is a day-by-day outline of the sections that will be discussed in class. You are fully expected to have read the upcoming section before the class meeting! This does not mean you need to understand everything, but rather you should be familiar with the definitions and concepts from the sections; having read the section will allow you to ask better questions and follow along better in class.

Practice Problems: Mathematics is learned by practice, and there is no substitution for putting pencil to paper and working lots of problems. Practice problems will be assigned virtually every class period and students are expected to work them all. These problems are not an individual component of your grade, but tie directly to the topics being studied and will prepare you for the tests. On any given day students should turn in any problems on which they wish to receive feedback.

Projects: There will be both a mini and a full project in this course. Both will require group work and a written report. The first mini project is prior to break and focuses on problem formulation. The second full project builds on this and requires formulation, solution, and analysis.

Late Work: Unless specific permission is given in advance of the due date, no late work will be accepted.

Grading: Components of a student's grade will be weighted as follows:

Tests: 90% Project(s): 10%

A grade scale will be determined after final averages are computed, but will be not be lower than the scale given below.

0	*60*	*63*	*67*	*70*	*73*	*77*	*80*	*83*	*87*	*90*	*93*
	F	*D-*	*D*	*D+*	*C-*	*C*	*C+*	*B-*	*B*	*B+*	*A-*	*A*

Cell Phones: This is very simple - no cells phones are allowed to be used or even visible in our classroom. This includes before, during, and after class. If a cell phone is seen, the student will be asked to leave the classroom and the day will be counted as an unexcused absence.

Academic Integrity: Students are expected to follow the integrity policy detailed in the handbook *Academic Integrity at Roanoke College*. Additionally, if you are ever uncertain as to how the College's policy pertains to any assignment or exam in this course, please ask me for clarification. The bottom line is that all work that a student submits for a grade must be ***solely*** the work of that student unless the instructor has given explicit permission for students to work together.

MCSP Conversations: The Math, Computer Science and Physics department offers a series of discussions that appeal to a broad range of interests related to these fields of study. These co-curricular sessions will engage the community to think about ongoing research, novel applications and other issues that face our discipline.

Sessions are currently being scheduled, and all will be announced in advance.

Members of this class are invited be involved with all of these meetings; however participation in **at least three** of these sessions is mandatory. After attending, students will submit within one week of the presentation a one-page+ paper reflecting on the discussion. This should *not* simply be a regurgitation of the content, but rather a personal contemplation of the experience.

Testing:

We will be making use of "Mastery-Based Testing". This system is very different from what you are used to – do not hesitate to ask me questions in class or my office at any time. In the mathematics community many are working with and researching this technique, one of the best starting sources for understanding can be found at https://mbtmath.wordpress.com. Much of what you'll find on the next two pages is taken from this resource.

Short Description:
You only receive credit for answers that demonstrate you completely understand (have mastered) a topic. But, you get many chances to display mastery throughout the semester with no penalty at all for earlier attempts.

Long Description:

The course has been boiled down to 18 essential types of questions, or "topics", your mastery of questions on these topics is assessed through four tests and the final exam. Each problem submitted is graded as either "Master" or "Not Mastered". A grade of Master indicates that you have demonstrated full understanding of the concept being tested and further work on the topic is not necessary. Once you have mastered a problem you need not ever attempt it again on a future test, including the final exam. There is no penalty whatsoever for multiple attempts taken to achieve mastery.

Test 1: Topics 1-5

Test 2: Topics 1-8.

Test 3: Topics 1-10.

Test 4: Topics 1-14.

Final Exam: Topics 1-14.

Your overall exam grade (tests and final) is then determined by the number of questions/topics you have mastered.

#Mastered	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Exam Grade	100	96	92	88	84	80	76	72	68	64	60	50	40	30

Notes on Master-Based Testing (in no specific order, credit to Austin Mohr)

- Clear content objectives, students continually know exactly what they need to work on to improve.
- Credit only for eventual mastery. No partial credit.
- Multiple attempts with complete forgiveness.
- A points-based system sets arbitrary deadlines by which time perfection must be attained or else penalties a
- Perseverance
  Points – try a problem once, maybe twice, hope for the best.
  Mastery – Keep trying until you succeed (and I know you can)
- Use of feedback on exams
  Points – do I agree with the instructors grading
  Mastery – what can I do to fully demonstrate that I understand the concept (improvement!)
- Reduced Test Anxiety
  Points – every test has the potential to damage your GPA.
  Mastery – no one test can harm your grade.
- Intelligent Test Preparation: You may actually choose to skip problems on a test. Better to achieve mastery on some than to demonstrate mediocrity on all. Given time constraints of the latter tests, most students will only be able to focus on 5-8 problems in 60 minutes.
- Formative Assessment
  Points: How many points is this error worth?
  Mastery: Will the student benefit from studying the concept again?
- No longer will any of us have to wonder just what exactly a 7/10 means on a problem compared to an 8/10…
- In most points-based systems, a blank exam question is a heavy blow to a student's grade. On the other hand, a student who provides a couple relevant formulas and something resembling the beginning of a solution may receive half credit or more. In the presence of constrained study time, a good strategy is to learn some basics about every test item. Such a student may earn half credit on most items together with a few lucky shots on easier items, which amounts to a passing grade overall. Take a moment to consider whether this experience has adequately prepared the student to apply mathematical thinking to nontrivial problems in the future.

  The "broad and superficial" strategy employed above earns no credit under a mastery-based system. Instead, a student who wishes to earn a passing exam grade must *fully* understand an appreciable subset of the main ideas of the course, and a student wishing to earn an A grade must *fully* understand most or all of the main ideas of the course. Even if students spend no time studying a particular item, I contend that the experience of pursuing deep understanding on the other items leaves them in a stronger position to engage deeply with the troublesome topic when it is needed in the future. Moreover, depth of understanding is critical to one's ability to apply existing mathematical knowledge in novel domains.

The Writing Center @ Roanoke College, located on the Lower Level of Fintel Library, offers tutorials focused on writing projects and oral presentations for students working in any field. Writers and presenters at all levels of competence may visit the Writing Center at any point in their process—including brainstorming, drafting, organizing, editing, or polishing presentation skills—to talk with trained peer tutors in informal, one-on-one sessions. The Writing Center is open Sunday through Thursday from 4 to 9 pm. Simply stop in, or schedule an appointment by going to www.roanoke.edu/writingcenter, where our staff members and workshops are also posted. Questions? Email writingcenter@roanoke.edu or call 375-4949. Like our Facebook page for hours and event updates!

Subject Tutoring, located on the lower level of Fintel Library (Room 5), is open 4 p.m. – 9 p.m., Sunday – Thursday. We are a Level II Internationally Certified Training Center through the College Reading and Learning Association (CRLA). Subject Tutors are highly trained Roanoke College students who offer one-on-one tutorials in a variety of general education and major courses such as: Business, Economics, Mathematics, INQ 240, Modern Languages, Lab Sciences, INQ 250 & Social Sciences (see all available subjects at www.roanoke.edu/tutoring). Tutoring sessions are available in 15, 30, or 45-minute appointments. Feel free to drop by for a quick question or make an appointment at www.roanoke.edu/tutoring for a longer one-on-one appointment. For questions or concerns, please call 540-375-2590 or subject_tutoring@roanoke.edu.

The Office of Disability Support Services (DSS), is located in the Goode-Pasfield Center for Learning and Teaching in **Fintel Library**. DSS provides reasonable accommodations to students with documented disabilities. To register for Disability Support Services, students must self-identify to the Office of Disability Support Services, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact JoAnn Stephens-Forrest, MSW, Coordinator of Disability Support Services, at 540-375-2247 or e-mail her at: stephens@roanoke.edu to schedule an appointment. If you have registered with DSS in the past, and would like to receive academic accommodations for this semester, please contact Ms. Stephens-Forrest at your earliest convenience, to schedule an appointment.

Course Schedule - This course expects you to spend at least 12 hours of work each week inside and outside of class.

Date		Topic	Section	Title
Thu	31-Aug		1.1-1.5	Introduction to Model Building
Tue	5-Sep		2.1-2.6, 3.1	Linear Algebra Review, Intro to Linear Programming
Thu	7-Sep		3.2, 3.3-3.6	Graphical Solutions and Applied Examples
Tue	12-Sep		4.1-4.3	Linear Programming Problems - Concepts
Thu	14-Sep		4.5	The Simplex Algorithm
Tue	19-Sep		Review	
Thu	21-Sep		**Test 1**	
Tue	26-Sep		4.6-4.8	Variations of the Simplex Algorithm
Thu	28-Sep		4.11-4.13	Degeneracy and Basic Feasible Solutions
Tue	3-Oct		6.1, 6.2	Into to Sensitivity Analysis
Thu	5-Oct		6.3	Sensitivity Analysis
Tue	10-Oct		Review	
Thu	12-Oct		**Test 2**	
----- Fall Break				
Tue	25-Oct		6.5, 6.6	The Dual of an LP
Thu	27-Oct		6.7, 6.8	The Dual Theorem / Shadow Prices
Tue	31-Oct		6.9, 6.10	Duality and Sensitivity Analysis, Slackness
Thu	2-Nov		6.11	Dual Simplex Method
Tue	7-Nov		**Test 3**	
Thu	9-Nov		7.1, 7.2	Transportation Problems
Tue	14-Nov		7.3	Transportation Simplex Method
Thu	16-Nov		8.1, 8.2	Network Models
Tue	21-Nov	15	8.3, 8.5	Variations of Network Flow Models
---- Thanksgiving Break				

Tue	28-Nov	16	9.1, 9.2	Integer Programming
Thu	30-Nov		Review	
Tue	5-Dec		**Test 4**	
Thu	7-Dec		Wrapup	
Tue	12-Dec		**Final Exam** 2:00-5:00 pm	

Here is the list of 14 topics for which you will be seeking mastery during this course. Note that the earlier topics will be available on all exams, while you will have fewer opportunities to master later topics as they occur later in the semester.

1.	Linear Programming Models	3.1
2.	Graphical Solutions	3.2
3.	Applied Problem Formulation	3.3-3.7
4.	Linear Programming Problems – Concepts	4.1-4.4
5.	The Simplex Algorithm	4.5
6.	Variations in the Simplex Algorithm	4.6-4.8
7.	Difficult Basic Feasible Solutions	4.11-4.12
8.	Sensitivity Analysis	6.1-6.4
9.	The Dual – Find and Interpret	6.5-6.7
10.	The Dual Theorem / Shadow Prices	6.8, 8.9
11.	Transportation Problems – Formulation	7.1, 7.2
12.	Transportation Problems – Solving	7.3
13.	Network Models	8.1-8.3
14.	Integer Programming	9.1-9.2