FOREST AND RANGELAND STEWARDSHIP
COLORADO STATE UNIVERSITY

F422 Quantitative Analysis in Forest Resource Management
Fall 2017 Syllabus

		Instructor	Co-Instructors
Name:	Instructor Name	Yu Wei	Name: Alex Masarie Dr. Dung Nguyen (F521 only)
Office:	Office Number	F 102	Office Number: F 112
Phone:	Phone for Office	1-2959	
E-Mail:	Instructor Email:	Canvas	E-Mail: alex.masarie@gmail.com or canvas
Office Hours:	Date and time	Thursday, 1:30-3:00pm M&W 2:50-3:10pm Or by appointment	Date and time: Wednesday, 3:00-5:00pm or by appointment

Term:	Fall 2016
Class Meeting Days:	MW
Class Meeting Hours:	2:00-2:50pm
Class Location:	Education Building Room 11
Lab time:	F: 2:00-3:40
Lab Location:	NR 232 or further notices
Course Credits:	Three

Course Overview

This course introduces quantitative analysis methods in forest resource management. These methods support landscape level forest management decision making and planning efforts. Students will likely find it valuable to maintain a steady pace, finish the lab assignments, get started on homework assignments as they are assigned and attend all the lectures and lab sessions. Lecture will often build on previous lectures.

Additional requirement for F521:

1) Understand Model II (HW5 and Lab 7);
2) Understand the basic principle of stochastic programming (Quiz 9);
3) Finish an individual project by developing and testing a real-world forest planning model for the Custer Gallatin National Forest using an open source software developed by a joint effort between CSU and USFS Region I. The name of the software is PRISM. Dr. Dung Nguyen is the software developer; he will help teach graduate students how to use the software.
4) 10 minutes classroom presentation of class project

Course Goals and Objectives

1. Goals: teach students to understand the concept of landscape forest planning, and to develop and use quantitative tools to assist landscape forest management decisions and planning efforts.
2. Objectives:
    a. Understand the objectives, concerns and management alternatives in landscape forest management.

b. Understand how management will influence the composition, growth and quality of a forest.
c. Explore landscape models in fire management, forest conservation, watershed erosion control, and wildlife habitat conservation.
d. Familiar with the commonly adopted landscape forest planning procedures in the U.S.
e. Solve forest management models by selecting appropriate computer software.
f. Analyze the tradeoffs between alternative management strategies when facing multiple forest management objectives.
g. F521 students: understand the complexity and challenging in real-world forest planning.

Course Prerequisites

1. F321 and F322
2. Basic knowledge of Microsoft Excel.

Course Policies

Late Work Policy:
There are no make-ups for quizzes. All labs are due the following week after assignment (by the end of the lab on Friday) unless specified by the instructor. Late homework, project report and lab assignments will not be accepted.

Requirement for class project:
For F422 students, a stylized forest management problem can be used to form a class project; for F521 students, a real-world forest planning problem will be presented to you as the base for a class project. Details about the UG project is prepared by Alex Masarie as attachments.

Grades of "Incomplete":
Per university policy, an instructor may assign temporary grade of Incomplete to a student who demonstrates that he or she could not complete the requirements of the course due to circumstances beyond the student's control and not reasonably foreseeable. A student must be passing a course at the time that an Incomplete is requested unless the instructor determines that there are extenuating circumstances to assign an Incomplete to a student who is not passing the course. When an instructor assigns an Incomplete, he or she shall specify in writing using the Department Incomplete Grade Form the requirements the student shall fulfill to complete the course as well as the reasons for granting an Incomplete when the student is not passing the course. The instructor shall retain a copy of this statement in his or her grade records and provide copies to the student and the department head or his or her designee. (Section I.6 of the *Academic Faculty and Administrative Professional Manual*)

Disability Access:
Colorado State University is committed to providing reasonable accommodations for all persons with disabilities. Students with disabilities who need accommodations must first contact Resources for Disabled Students before requesting accommodations from the professor. Resources for Disabled Students (RDS; http://rds.colostate.edu/home) is located in room 100 of the General Services Building. Their phone is (970) 491-6385 (V/TDD). Students who need accommodations in this course must contact the professor at the beginning of the semester to discuss needed accommodations.

Attendance Policy:
Attending classes, labs and discussion sessions are required for this class. A student may fail this class if more than 25% of the scheduled class time is missed. Participation in official University activities, e.g., an out-of-town athletic event, or special religious observances may provide a legitimate reason for an excused absence. Student is responsible of discussing these activities with the instructor at the beginning of the semester.

Professionalism Policy:
Per university policy and classroom etiquette; mobile phones, iPods, *etc*. **must be silenced** during all classroom and lab lectures. Those not heeding this rule will be asked to leave the classroom/lab immediately so as to not disrupt the learning environment. Please arrive on time for all class meetings. Students who habitually disturb the class by talking, arriving late, *etc*., and have been warned may suffer a reduction in their final class grade.

When emailing the instructor, please include your full name, CSU ID, and the course number in your email.

Academic Integrity (enforced strictly):

The Department of Forest and Rangeland Stewardship takes academic integrity seriously. At minimum, academic integrity means that no one will use another's work as their own. The CSU writing center defines plagiarism this way:

> Plagiarism is the unauthorized or unacknowledged use of another person's academic or scholarly work. Done on purpose, it is cheating. Done accidentally, it is no less serious. Regardless of how it occurs, plagiarism is a theft of intellectual property and a violation of an ironclad rule demanding "credit be given where credit is due."
> Source: (Writing Guides: Understanding Plagiarism.
> http://writing.colostate.edu/guides/researchsources/understandingplagiarism/plagiarismoverview.cfm.
> Accessed, May 25, 2012)

If you plagiarize in your work you will fail the assignment (for the first time), or fail the course (for the second time or above). Each instance of plagiarism, classroom cheating, and other types of academic dishonesty will be addressed according to the principles published in the CSU General Catalog (see page seven, column two: http://www.catalog.colostate.edu/FrontPDF/1.6POLICIES1112f.pdf).

Of course, academic integrity means more than just avoiding plagiarism. It also involves doing your own reading and studying. It includes regular class attendance, careful consideration of all class materials, and engagement with the class and your fellow students. Academic integrity lies at the core of our common goal: to create an intellectually honest and rigorous community. Because academic integrity, and the personal and social integrity of which academic integrity is an integral part, is so central to our mission as students, teachers, scholars, and citizens, we will ask to you sign the CSU Honor Pledge as part of completing all of our major assignments. While you will not be required to sign the honor pledge, we will ask each of you to write and sign the following statement on your papers and exams:

"I have not given, received, or used any unauthorized assistance."

Course Schedule

Week	Topic	Assignments	Lab and Class Project
1	Introduction to landscape forest management.	Read chapter 1	Excel exercise - Lab 0: no grade will be assigned
2	Principles of linear programming.	Read chapter 2, 3.1 to 3.3, 3.4, and 3.5 HW1	Lab 1: The Ponderosa Pine forest problem
3	Even-aged forest management	Read chapter 4	Review and discussion
4	Regulated forest, area control and volume control	Read chapter 5	Lab 2: Even-aged forest management
5	Dynamic model and long-term forest planning	Read chapter 6 HW2	Lab 3: LP in area control and volume control
6	Uneven aged management	Read chapter 8	Lab 4: The dynamic model and long-term forest planning
7	Forest planning using Model I (F521 students also need to learn Model II)	Read the handout (HW5 GS only)	Lab 5: Model I formulation
8	Forest planning with multiple economic and ecological objectives	Read chapter 10 HW3	Review and discussion
9	Use integer program in landscape forest management	Read chapter 11	Lab 6: Introduction to Integer Programming
10	Select reserve sites for better landscape forest conservation	Read the handout HW4	Class project (Lab 7: F521 only -- using PRISM; Dr. Nguyen)
11	Make decisions in wildland fire management – suppression	Read the handout	Class project
12	Make decisions in wildland fire management – fuel treatment – erosion control	Read the handout	Class project
13	Introduction to stochastic programming (Quiz 9 for GS only)	Read the handout	Class project
14	Building systems models to solve natural resource management problems	Read the handout	Class project
15	Project presentations	Project report due	

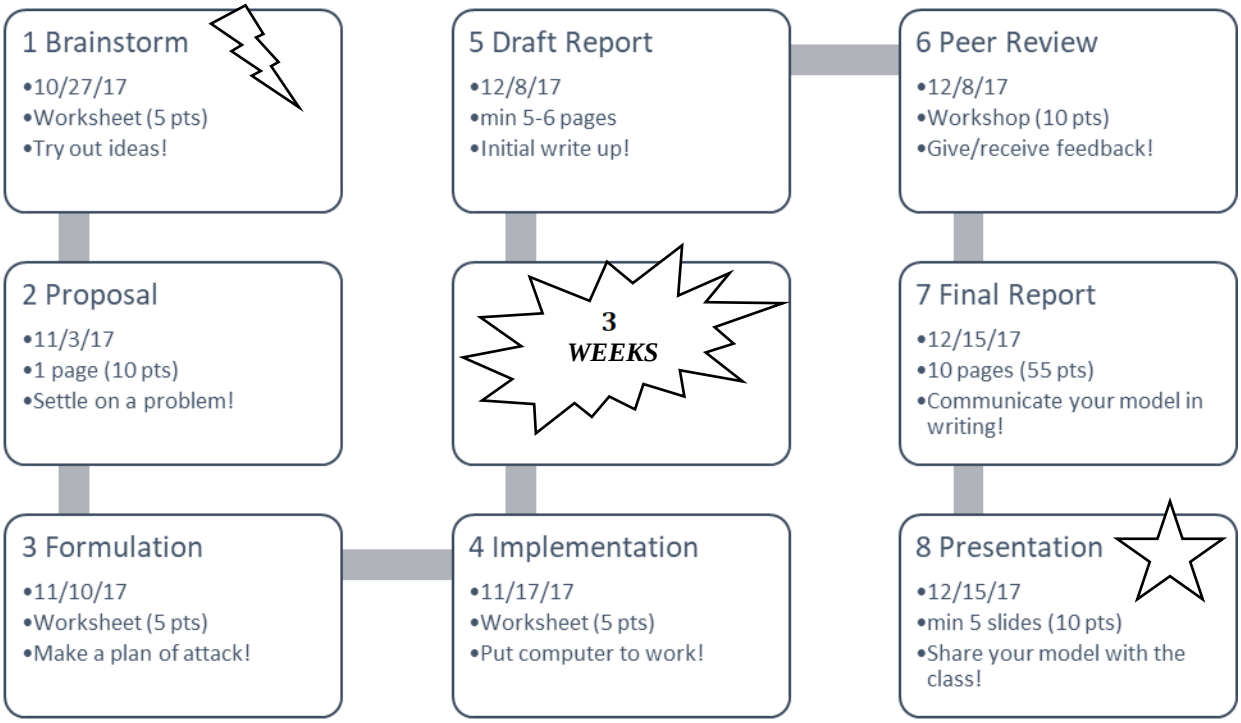
Basis for Final Grade

Assessment	Percent of Final Grade
Lab (6 for UG; 7 for GS)	36%
Homework (4 for UG; 5 for GS)	28%
Weekly quiz (8 for UG; 9 for GS)	24%
Project	12%
Total	100%

Grading Scale (%)	
90-100	A
80 - 89	B
70 - 79	C
60 - 69	D
0 - 59	F

ROADMAP: Quantitative Modeling Project (prepared by Alex Masarie)

Quantitative Methods in Forest Management – Forestry 422 – Fall 2017



(@you) Project assignment materials including scoring materials to start us off

1>>2
- (@you) Most of course content, some guidelines for making a good problem
- (@us) Brainstorm worksheet at the end of lab session

2>>3
- (@you) Feedback on brainstorm, guide on how to write proposal from brainstorm
- (@us) Written proposal

3>>4
- (@you) Reading response specific to the type of model you might use, sample projects
- (@us) Completed implementation worksheet

4>>5
- (@you) Lab time to work and address project issues, Fall Break (yaaay!)
- (@us) Draft report

5>>6
- (@you) Guided peer review workshop, lab session to complete activities
- (@us) Participation in workshop with thoughtful/respectful feedback

6>>7
- (@you) Peer review comments, focus on audience tips
- (@us) Final report

7>>8
- (@you) Sample presentation
- (@us) Present out the awesome model you have built and tested!

ASSIGNMENT: Quantitative Modeling Project
(prepared by Alex Masarie)

Quantitative Methods in Forest Management – Forestry 422 – Fall 2017

Course Summary from Alex's view

Humans have a symbiotic relationship with forest resources and we must continually assess the impact of our land stewardship. This course introduces objective-based math programming as a technique to manage forests. By clearly stating the objectives, constraints, and parameters of problem, we can choose the best course of action among many decision alternatives. Our course goal is to use linear, integer, and stochastic programs to develop meaningful recommendations to support data-informed decisions when multiple, competing priorities are apparent. Applied problems from forest harvest scheduling, fuel treatment configuration, road network planning, and fire suppression management will be considered.

Project Assignment

Students will produce an >= 5 page project report applying a model to a management problem of interest. Several intermediate assignments will build towards the final report. Writing the final report will be a matter of connecting these assignments into a complete management context. You will make extensive use of computing technology to complete this work. Students will report their application to the class by giving a 5-10 minute wrap-up presentation.

Project Goals

- Guide students through a model development process,
- Analyze a management context problem of interest,
- Communicate through writing assignments of mixed length,
- Write a final synthesis and discuss results.

Specifics will accompany each assignment, but here is a general timeline:

	Assignment	*Description*	*Points*	*Due Date*
1	Brainstorm	Narrow problem focus and develop plan of attack **(worksheet)** *[LAB NR232]*	(10)	**10/27/17**
2	Proposal	Emphasize key ideas, state methods from the course, and outline procedure **(1 page)** *[READ/RESPONSE HW]*	(20)	**11/3/17**
3	Formulation	Resolve technical details, practice applying model to numbers **(worksheet)** *[WORKSHOP F127]*	(10)	**11/10/17**
4	Implementation	Program computer to correctly apply the model and report relevant results **(worksheet)** *[LAB NR232]*	(10)	**11/17/17**
5	Report and presentation	• Connect management backstory, describe methods **(minimum 2 pages)** • Clarify results **(minimum 2 pages)** • Share main ideas and tell some interesting details about the project with focus on management support *[LAB NR232]*	(20) (20) (10)	**12/08/17**

Format

- Page guidelines reflect writing in 11 point font, double spaced.
- Figures, tables, and diagrams will be an important part of explaining the application. They should be explained and cited within the text.
- All spreadsheet implementations from intro labs may be modified to support project work.
- Presentations should highlight project work while keeping within the 5-10 minute allotted time.

Topics

(Management context) Students will select one of the following:

- forest harvest scheduling,
- road network planning,
- fuel treatment configuration,
- fire suppression management,

and develop a creative who/what/when/where/why/how problem backstory to give the quantitative project real world substance. Writing the report will entail connecting this project backstory to the model to bring the numbers to life, so to speak, and demonstrate how forest-level management benefits from this type of rigorous exploration. The report will provide

necessary detail to select, among many alternative decisions in the feasible region, a "best" option and explain in what sense it is "best" as well as how it conforms to all problem constraints.
(Methods) Students will use the problem's management context to elect specific linear, integer, and/or stochastic programming techniques covered in the course. These techniques will form the core of the model, which will then be used to tackle a well-defined test case thereby quantitatively justifying an optimal plan. The report should synthesize an action plan with a focus on stewardship.

Audience

Imagine all your efforts aim for an official meeting with a project manager. They will be receiving your final report, meeting with you to hear you present, and asking specific questions about both. This individual is ultimately responsible for taking management action. Whether they are spending from a program budget, making a judgement about the safety of fire personnel, or developing a cohesive sustainable natural resource plan, you should assume this decision maker is under pressure. As such, it is your job to explain how quantities in your model can inform their decision. Think about explaining the model in layperson's terms so the manager feels comfortable about using the information you provide.

Creativity and Teamwork

Creativity is a pivotal part of this project. This means clever story-telling, but also being creative with *how* you apply the quantitative techniques we learn in class to your own management situation. Over the years these very math programming methods have been crucial decision-making tools on countless problems! How will you adapt them to suit your context? You may work individually or in groups of two (2), three (3), but no more than four (≤ 4) students as suits your learning preferences. These groups will be formed at the proposal stage and if you choose this route the final report will be collaboratively written (one report per group) and the final presentation will be a team effort. Of course, collaboration among everyone is encouraged in project lab sessions as each project will pose unique, interesting challenges.

Grading Criteria – Final Report and Presentation

An analytic rubric will be available to guide the writing process, but below is a brief outline of how this project will be assessed:

		Points
Understanding and Analysis of Model (Has the student built a model that demonstrates correct use of course techniques? Is the analysis effective?)	Excellent Very Good Good Average Poor	(30)
Rationale of Optimal Plan (How useful is the model's solution to the management audience? Are the decision variables, objectives, constraints, and parameters explained?)	Excellent Very Good Good Average Poor	(25)
Structure and Writing Quality (Logic, coherence, spelling, grammar, and general fluency all count. Does the writing consider the management audience?)	Excellent Very Good Good Average Poor	(10)
Presentation (Are the deliveries of the background story, problem statement, and selected model easy to follow? Is the computation strategy concisely explained? Do the results and test case relate the model to the management context?)	Excellent Very Good Good Average Poor	(10)
	TOTAL	

*Late penalties will be assessed at (-2) points per day

BRAINSTORM: Quantitative Modeling Project
(prepared by Alex Masarie)
Quantitative Methods in Forest Management – Forestry 422 – Fall 2017
(Due: Friday 11/3/17) **(5 points)**

This assignment is a guided exercise to support your individual/group project work. The goal is to sketch out many aspects of the project so our remaining lab time can be most useful to you. Our hope is that you can quickly elect an interesting problem to work on, gradually work towards a solution, and all the while create documentation that will facilitate the final report.

1. *(Problem Statement)* All projects need to be based on a problem statement. (Hint: Refer to Labs, Homework, and Quizzes for examples of how to state a problem). Parts a., b., and c. will help you write this statement clearly.
    a. Circle which project you will work on:

Forest-Level Model I or Network Flow or Managing fire

    b. What is your problem objective?

    c. Please give the units of measurements of the objective function.

    d. What will constrain your problem? Please mention at least 3 constraints.

2. *(Model and Methods)* You will be building a model for your chosen problem and applying the methods we have covered during the course to solve it.
    a. Given your choice in 1.a., of the Labs, Homework, and Quizzes we have done, which one(s) will be a good reference for your project work?

    b. For one of the references listed above, please write 1-2 sentences specifying what part of this course assignment you will be using in your project work.

    c. Draft a clear project title that mentions something about your problem and something about the methods. Write your project title below.

3. *(Computing)* Our coursework has involved several computer programs as resources to solve and communicate management problems. This section focuses in on your ability to get the computer to give you an optimal solution to your problem.

    a. Fill in the summary table below to help plan out your computer work for this project.

Must use	*Use again (pick 2 or more)*	*Challenge*
✓ Microsoft Excel ✓ PowerPoint*	☐ Microsoft Word ☐ Convert to PDF ☐ Microsoft Paint ☐ Canvas discussion board	☐ Google Earth ☐ MATLAB ☐ ArcGIS ☐ FARSITE ☐ Flammap ☐ WindNinja ☐ BehavePlus ☐ Landfire.gov ☐ Forest Vegetation Simulator ☐ Other**: _____

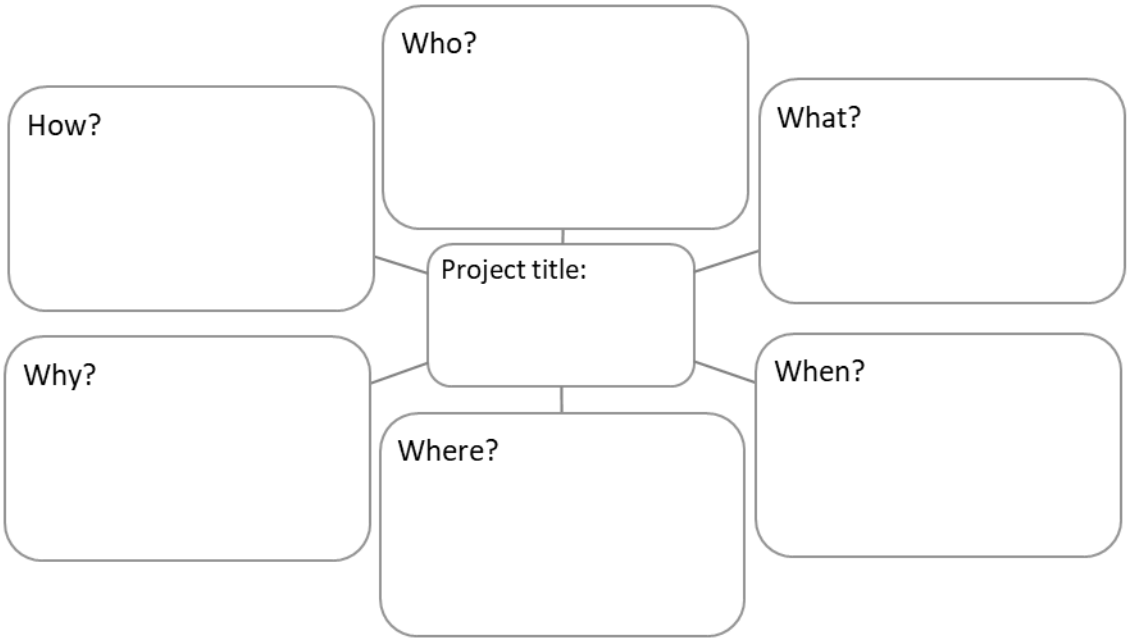
* Or some other presentation software (must be approved ahead of time)
** Also must be approved ahead of time

    b. Use the timeline below to start scheduling the work in these programs.

4. *(Study Results)* Our audience for this project are managers or people that would be interested in your solution of this particular problem. Which of the following will you use to report the decision variables and optimal solution you find to this audience?

(Check all that apply)	***Notes***
☐ Spreadsheets and tables	
☐ Descriptive paragraphs	
☐ Shadow prices	
☐ Binding/non-binding constraints	
☐ A diagram (forest age, network, other)	
☐ Tradeoff analysis	
☐ Slack variables	
☐ Equations	
☐ Other: _____	

5. *(Background)* Motivating your model with some real-life scenario will be your chance to tell a story about the project and make it come to life. Fill in the mind map below to organize some thoughts about this narrative.



6. *(PowerPoint*)* Thinking way ahead, we wish to communicate that optimal solution to others. Our final task is to get back to (or get into for the first time) using PowerPoint* to convey ideas to an audience. These questions will help you think about your presentation as you work on the project and not just the end.

   a. Complete the effective presentation fill-in-the-blank below.

interesting details	as little of	vomited	5	400	bored
decision	half of	big ideas	communicates	choice	practiced
20	as much of	mad	50	decision	lost

An effective presentation _____ results of a project clearly and concisely at a level that is understandable for _____ the audience as possible. It is very difficult to give an effective presentation for more than _____ minutes and most only take between ____ and ____ minutes. In a quantitative presentation the speaker must make a conscious _____ about the storytelling behind the numbers, graphs, and tables so the listeners do not get_____.

An effective presentation balances _____ with _____ and it is apparent that the speaker _____ many times beforehand.

b. Think of a time you saw or gave a presentation that *was particularly effective*. What are three hints you learned from this effective presentation?

c. Think of a time you saw or gave a presentation that you thought *was **not** very effective*. What are three pitfalls or mistakes presenters sometimes fall into?

d. Make a draft of a Project Outline slide for your project. Make sure to:

- ☐ Use an appealing slide design (or make your own)
- ☐ Set a large font with only a few words on the screen
- ☐ This is a list of topics for your outline slide:

1. Background ; **2.** Problem Statement ; **3.** Model ; **4.** Methods/Computing ; **5.** Results

PROPOSAL: Quantitative Modeling Project
(prepared by Alex Masarie)
Quantitative Methods in Forest Management – Forestry 422 – Fall 2017
(Due: Friday 11/10/17) **(10 points)**

This assignment will use the project brainstorming handout to make your final project proposal.

Write your project title **(0.5 points)**:

1. *(Problem Statement)* Use parts 1.a. - d. of the brainstorming handout to state your problem. Please provide 2-3 complete sentences. **(2 points)**

2. *(Model)* State which model you plan to use (not the equations, just the type). Give all the detail you can in 1-2 complete sentences. **(1 point)**

3. *(Methods)* Use parts 2.a. – b. of the brainstorming handout to describe the methods you will use. Please provide 1-2 complete sentences. **(2 points)**

4. *(Data)* Where do you plan to obtain data for your program's parameters? Please provide 1-2 complete sentences. **(0.5 points)**

5. *(Study Results)* Use parts 3 and 4 of the brainstorming handout to write about the results you expect from your project and how you will communicate them. Please provide 2-3 complete sentences. **(3 points)**

6. *(Test Case)* Use part 5 of the brainstorming handout to describe a real-world test case you plan to study with the model. Please provide 1-2 complete sentences. **(1 point)**

FORMULATION: Quantitative Modeling Project

(prepared by Alex Masarie)

Quantitative Methods in Forest Management – Forestry 422 – Fall 2017

(Due: Friday 11/17/17 at 2:00pm) **(5 pts)**

The purpose of these exercises is to help you formulate your model as a linear program.

7. *(Problem diagram)* Use the space below to produce a diagram of your problem set-up.

8. *(Decision variables)* Specify your decision variables below.

9. *(Objective function)* Draft your objective function.

10. *(Constraints)* Write down all the $\leq$, $\geq$, and $=$ constraints your model will enforce.

11. *(Testing by hand)* To develop intuition about your model we will solve a restricted version of by hand. Work on the graph paper provided (you can scan it into this document later). Use the following procedure.
    a. Consider one of the constraints from part 4. Choose two decision variables from this constraint, write one on the horizontal axis, and the other on the vertical axis.
    b. Draw a line for the constraint as well as any other constraints where these two decision variables appear. Indicate the feasible region.
    c. Draw an Iso objective function line by restricting part 3. to the two decision variables you are working with. Use the Iso line to find a graphical optimal.
    d. What are the values of the decision variables at the optimal?

    e. What is the objective function value?

    f. Which constraints are binding and which are non-binding?

12. *(Moving into Excel)* To move your model into Excel you will need to carefully organize your spreadsheet(s). You can refer to the textbook or course materials to see example spreadsheets, but here are some general hints:
    - Don't forget to include space for parameters, changing cells, the >= or <= or = sign for constraints, left hand side (LHS) and right hand sides (RHS) for each constraint, and objective function value.
    - Organize your rows and columns consistently (i.e. for Model I we saw time periods in columns and prescriptions in rows). Also, leave some space for intermediate column sums and row sums that might be useful to communicate your results.

- Add some color or text emphasis. The better your spreadsheet looks, the less work you will have down the line to put your optimal spreadsheet solutions into the project report.
- Think about which cells Solver will need to reference to know your objective function value and constraint information.