Take-Home Final Exam

Astro 289, Winter 2016

Due by 11:59 pm on Thursday March 17 (last day of Exam Period)

Your written reports on your class projects are also due 11:59 pm Thursday March 17.

Please email to Claire or hand in paper copies to Graseilah Coolidge in ISB 375

Exam rules and goals:

a) The goal of this exam is to provide a strong incentive for each of you to review the lectures and your own notes. Please take this opportunity to synthesize for yourselves what you have learned in this course, so that you can make it your own.

b) This is an open-book take-home exam. Do it YOURSELF, without consulting other students. But feel free to consult all the lectures and readings on the class website, plus your favorite reference books and your notes. I do NOT want you to spend time roaming the web to find answers, so the only websites you may use are our own class site, and the concept map websites linked to from our class site.

c) There is no particular format for your responses. But please write legibly.

d) What I am most interested in is your conceptual understanding of adaptive optics. So when you write out your answers to the exam questions, include as much explanation as possible. I want you to write down the physical reasoning you used to reach each answer, in words or equations or both. Draw sketches wherever appropriate to illustrate your ideas.

e) Include UNITS in all equations and formulae.

f) In the spirit of continuing your transition from classroom students to researchers, I invite you to include in your exam your musings, questions, and hypotheses about issues that arise in the course of reading the exam questions and in the course of your review of the lectures and textbook. I want to see you think about the meaning and implications of what you are doing. (There will be extra credit for your musings …)

g) Remember to put your name on each page of your exam.

The exam will be in three parts, which are described in the following pages:

Part I.	Review
Part II.	Exam Questions
Part II.	Feedback to me on how to improve this course in the future

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Part I. Review

a) Before you start the rest of this exam, take at least 3 hours to go over the lectures, your notes, and the readings. If possible do this the day before you start to work on the exam itself. **Write down on the front page of your exam paper the times and date(s) when you did this review.**

This is to encourage you to step back and take time to synthesize the material in the course. I know that you could all just sit down and work on the exam, and that you're rushed with lots of other things to do. But at least in my experience, reviewing is the best way I know to have course material "stick" after the course is over. And that's the point.

b) **On the front page of your exam**, write down the three AO concepts and their corresponding equations that you think will be most useful to you in the future. Write a short paragraph about why each might be useful.

Part II. Exam Questions

1) "Concept Map" of AO

Concept maps can be a useful method to synthesize knowledge in a topic or field. They seek to lay out the important elements or concepts, show how they relate to each other, and indicate causation or dependence between them.

I would like you each to make your own concept map that pulls together the adaptive optics concepts you've learned in this course. Please use this concept-mapping exercise to review the course material and put the various parts in relation to each other.

For a refresher on concept maps, I've placed several items on the class website, at: http://www.ucolick.org/~max/289/ConceptMapLinkPage.html

This page includes some examples of concept maps for technical topics, to set the stage. Read these.

It also includes a link to instructions for how to make your own concept map. Please do NOT spend a bunch of time cruising the web and reading more instructions besides these. I am not looking for a specific format.

I'm looking for a concept map that goes into a fair amount of depth about AO. You should go down at least one or two levels below each AO subsystem (e.g. 2 levels below the "wavefront sensing" or "deformable mirror" subsystems), to show what other factors influence these subsystems and how the subsystems are related to other parts of the AO system. In these concept maps the relationships are just as important as the specific subsystems. For example you might want to show how the wavefront sensor integration time influences both the measurement error and the bandwidth error.

2) Outrageous statement?

In the very first lecture of this course, I made the following (possibly overly dramatic) statement, complete with exclamation mark:

"Even the largest ground-based astronomical telescopes have no better resolution than an amateur telescope you might use in your back yard!"

a) Describe the physics behind this statement. Define what you mean by "resolution". Use words, equations and sketches in your answer.

b) Define quantitatively the conditions under which the statement in quotes above is true. (It isn't true all the time!) What are the assumptions you are making?

3) Point spread functions (PSF)

a) Define the point spread function in at least two ways. Explain why it is important.

b) Draw a rough sketch of the PSF produced by an astronomical AO system with Strehl of 70% in a long-exposure image. Label all of the important features. Indicate on your sketch expressions for the approximate dimensions of the main features in the PSF. Draw the corresponding MTF and indicate the important features and scales on your sketch.

c) Draw a sketch of the effects of image motion on the PSF in b) above.

d) Actually measuring the PSF during an astronomical observation is difficult. What ways can you think of that would enable observers to have at least an estimate of what the PSF was doing during their observation?

4) Laser Guide Stars

a) Why are laser guide stars needed, for astronomy? Be quantitative. Are there astronomical science programs for which laser guide stars are not useful or not needed? What are they, and why not?

b) Describe the two main types of laser guide stars. Draw a sketch illustrating each. Explain the physical mechanism that scatters the light back into the telescope, for each type.

c) What are the relative advantages and disadvantages of the two main types of laser guide stars?

d) What factors limit the performance of sodium laser guide stars for astronomical AO? Give equations where appropriate.

Part III. Feedback to me on how to improve this course in the future.

This section is intended to give me your feedback on how to improve this class (and other graduate courses I may teach) in the future. You do NOT have to put your name on this section of the exam, unless you want to. If you wish you may hand it in as a separate, self-contained item (stapled together so the two pages don't wander off on separate paths).

A) How useful and/or valuable were the following aspects of the class:

	Not very useful	Useful	Very useful	Comments: how can these be improved? (continue comments below if there isn't enough room here)
Lectures: ppt slides				
Lectures: discussions and concept questions				
Class website				
Assigned readings				
Homework				
Class project				
What aspect of the Class Project was the most useful? The least useful?	na	na	na	Please comment here or below:

For video users only:

a) Please suggest concrete ways in which I can improve the class experience of future video users.

b) What aspects of your video experience worked, and what didn't work?

c) Would an on-line discussion group or chat room be attractive to you?

Take a deep breath. You have finished your exam.

It's been fun working with you all -- you're a great class (really!). Best of luck to you.

Claire