

Astronomy 203/203W/403: astronomical instruments and techniques

Fall 1999

This document is available on the World Wide Web, at
<http://www.pas.rochester.edu/~dmw/ast203/Syllabus.htm> .

Astronomy 203/403 is an introduction to the tools of modern observational astronomy. We will discuss geometrical and physical optics applied to telescopes and astronomical cameras, the physics of light detection at radio, infrared, visible, x-ray and γ -ray wavelengths, and the instruments and techniques used for observations of faint celestial objects over the full useful range of spectral and angular resolution. The intention is to provide to students the preparation necessary to design, build and optimize astronomical instruments. However, the material should be useful to anyone who will be using remote-sensing instruments, astronomical or otherwise, or seeks to understand measurements made with such devices.

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World Wide Web site: <http://www.pas.rochester.edu/~dmw/ast203/> . In this site one will find complete lecture notes, homework solutions, a practice examination, and links to other useful Web sites, as well as a copy of this document.

Textbooks: E. Hecht, *Optics*, third edition (AST 203); D.J. Schroeder, *Astronomical optics* (AST 403); G.H. Rieke, *Detection of light* (AST 403).

Software: MathSoft, *Mathcad 8.0 for Windows 98 and Windows NT (student edition)*; J.R. Houck and T.L. Herter, *RayTrace 5.0 for DOS*; Adobe, *Acrobat Reader 4.0* (or *Acrobat 4.0*); Microsoft, *Internet Explorer 5.0* or Netscape, *Navigator 4.61*. Mathcad is a general purpose, math-spreadsheet program and is merely recommended for this course; it is available at UR Computer Sales. The other programs are required, but free, and all can be downloaded using links from the Astronomy 203 Web site. RayTrace is a geometrical-optical design program that we will use for ray-tracing exercises. The other programs are necessary for viewing and printing the course material available on this Web site.

Lectures: Tuesdays and Thursdays (except 11/25/99), 11:05 AM–12:20 PM, in 407 Bausch and Lomb. Lecture notes will be posted on our World Wide Web site (see above); much of the material we will cover does not appear in any of the books.

Recitations: Fridays (except 9/3 and 11/26/99), 11:00-11:50 AM, in 407 Bausch and Lomb. We will use the recitations primarily for supplementary instruction on topics such as Mathcad and RayTrace, to work out examples and answer questions of general benefit to the class, and to work *en masse* on some of the more complicated computer-intensive homework problems.

Homework assignments: Eight problem sets, assigned at regular intervals during the term. Each problem set counts equally toward the final grade. Normally, detailed solutions to the problem sets will be posted on our World Wide Web site, and distributed in printed form, at the time they are due. This will make it difficult to accept late homework.

Term paper (AST 203): One research paper, approximately 5000 words in length, in which an instrument or technique in astronomical detection, spectroscopy, imagery, or remote sensing is described in detail, using the principles and methods presented in class to the greatest extent possible.

It need not be very long (at least 5000 words, not including equations and illustrations), but should represent a thoughtful summary and elaboration of two or three journal papers or the equivalent. I would prefer for the topic to be chosen from among these four:

- Geometrical errors in the Hubble Space Telescope, and how they were corrected
- Correctors for telescopes with spherical primaries: the Arecibo radio telescope and its recent upgrade
- Correctors for telescopes with spherical primaries: the Hobby-Eberly spectroscopic survey telescope
- Zoom lenses

but will consider other suggestions. Titles must be submitted for approval by the day before Fall Break, 10/1/99, and the final version must be handed in by 5PM, 11/5/99. I am willing to read and comment on any rough drafts you wish to submit, up to the day before the final version is due. The paper will be graded on how well and completely the chosen topic is discussed. Fractions of a grade may be taken off if the title or draft is turned in late, or if the presentation or English are below standard. Use of a word processor is required for this paper. In view of the term-paper requirement one may find it practical to take the class as Astronomy 203W, the form that can be used partially to satisfy the College upper-level writing requirement.

Many find it helpful to consult a good style manual during the preparation of papers. *The Elements of Style*, by W. Strunk Jr. and E.B. White, is an excellent (and brief) text from which to learn the art of vigorous prose composition. Copies of Strunk and White can be found for sale in the UR bookstore (or for that matter almost any bookstore), and may also be checked out of the Rush Rhees Library.

Upper-level writing option (AST 203W): Students who wish to use work prepared for this course partially to satisfy the College upper-level writing requirement may do so as follows. Some of the weight of the final examination (amounting to 10% of the weight in the final grade) would be replaced by scores on English usage in essays and the term paper. Each “essay” will consist of a detailed writeup of solutions for homework sets 2-8. The physical content of these problem sets will be graded as usual, but in addition there will be a score given on English usage. This policy may seem somewhat strange to those used to cryptic writeups for upper-division physics problem sets; a sample of what is expected will therefore be provided in the solutions to Problem Set #1 (and all succeeding problem sets). The use of a word processor with math typesetting capability (e.g. Microsoft Word) or a math spreadsheet with acceptable word processing capability (e.g. Mathcad) is required.

Those choosing the upper-level writing option must also turn in at least one rough draft of their paper, by 5PM, 10/29/99. These drafts will be returned, with comments, criticism and corrections on 11/2/99.

The English-usage scores on homework problem sets and the term paper (which will count a factor of three more than a single homework set) contribute 10% of the final grade; that is, the English score on each of homework sets 2-8 counts for 1% of the final grade, and that on the term paper counts for 3%.

Examination (AST 203): One (comprehensive) final exam, at 8:30 AM on Sunday, 12/19/99.

Term project (AST 403): One oral presentation, to me and to whomever else in the class wants to attend. This project would involve a description of *the complete conceptual design of an astronomical instrument* (which you may even be planning to build!). I emphasize *complete*: one must discuss the astronomical motivation for the instrument, optics, detectors, filters, spectrometers, polarizers, backend electronics, projected sensitivity, *etc.* One may choose any sort of instrument or application one wants; I will provide suggestions upon request. The presentations should not last longer than one hour. To

enforce this requirement, I will allow no individual to use more than *twenty viewgraphs*. The presentations may be scheduled, by appointment, at any time before the last day of classes, 12/10/99.

Grades: for undergraduates, based 40% on the homework, 25% on the term paper, and 35% on the final exam. For those taking this course as Astronomy 203W, the weight of the final exam decreases to 25%, and 10% of the course grade is based upon English-usage scores on the homework and term paper, as described above. In terms of the percentage of the maximum possible score, the grading scale will be as follows:

Percentage score	≥ 80	≥ 75	≥ 70	≥ 65	≥ 60	≥ 55	≥ 50	≥ 45	≥ 35	< 35
Final grade	A	A-	B+	B	B-	C+	C	C-	D	E

Last time Astronomy 203 was offered (Fall 1997), the class average percentage score was 63.3, for a B-.

For graduate students, the grade will be based completely upon the oral presentation. Grad students are expected to do (and hand in) the homework as well, for the grade earned on the oral presentation to count.

Academic honesty disclaimer: For our purposes, *cheating* consists of submission of term papers or homework or exam solutions that are not one's own work, or submission of such work under someone else's name. According to University rules, any detected act of cheating that is not the result of a simple misunderstanding must be handed over to the Board on Academic Honesty for investigation.

Help: My *official* office hours for Astronomy 203/403 are Tuesdays and Thursdays, 2-5 PM. I can, in general, be found in my office or my lab most every day, and unless I'm in a panic I will be happy to interrupt whatever it is I'm doing to talk to you. You may also reach me easily by electronic mail, and will often find me reading and responding to e-mail late at night before homework is due. However you reach me, I will be happy enough to deal with specific questions about the course, homework, term projects or exams. I would be even more interested in talking to those who find the material confusing enough that they're not even sure what to ask.