DEPARTMENT OF PHYSICS AND ASTRONOMY, UNIVERSITY OF NEW MEXICO

Astronomy 426/526 (ASTRO 426/526 001) – Optics and Instrumentation

Fall 2019

Instructor: Prof. Darcy Barron
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Office Hours: TBA, also by appointment

Teaching Assistant: Kayla Mitchell, email: kmitchell3@unm.edu

Course Description: Principles of optics and quantum physics applied to modern astronomical instrumentation (over a wide range of electromagnetic wavelengths), data acquisition and processing.

Prerequisites: There are no official prerequisites for this course, but students are expected to have a background in general physics, algebra, calculus, and basic computational and programming skills.

Course Goals

After completing this course, the student will be able to:

- Understand the fundamentals of how instruments at multiple wavelengths collect and affect data (imaging, spectroscopy, interferometry, etc.)
- Develop awareness of current state of the art instrument technologies and techniques across the electromagnetic spectrum.
- Understand how noise and instrumental artifacts can affect data
- Perform basic statistical analysis of datasets

Textbooks: Measuring the Universe: A Multiwavelength Perspective by George H. Rieke
ISBN: 978-1-108-40523-2 (paperback), 978-0-521-76229-8 (hardback)

Practical Statistics for Astronomers 2nd Edition by J. V. Wall and C. R. Jenkins
ISBN: 978-0-521-73249-9 (paperback)

Course Schedule: Lectures: MW 4:00PM-5:15PM P&A 184

Grading Policy:

Mid-term Exam	15%
Final Exam	15%
Homework	30%
Final Project	30%
In-Class Participation	10%

This is a dual enrollment course for both undergraduate and graduate students. This will be taken into consideration in the grade assignments for this class.

Undergraduates will be expected to perform at a level that is appropriate for an upper level student, including spending an appropriate amount of time on course work and projects.

Graduate students will be expected to show greater mastery of the material, as appropriate for an individual working toward a professional career in science. As a result, graduate students may be asked to complete additional or more advanced work during the course of the semester.

Homework will be assigned throughout the semester. Homework and projects will be due at the beginning of the class on the due date, as solutions to some problems will be discussed in class. You are encouraged to work together and exchange ideas in groups, however, anything you turn in for a grade must be your own work.

This is a three credit-hour course, which meets for two 75-minute sessions of direct instruction for each week of Fall 2019 semester. Students are expected to complete a *minimum* of six hours of out-of-class work (including homework and class preparation) each week.

Grade Cutoffs: A+ (>97.99%), A (>92.99%), A- (>89.99%), B+ (>87.99%), B (>82.99%), B- (>79.99%), C+ (>77.99%), C (>72.99%), C- (>69.99%), D (>59.99%), F (≤59.99%). These are the maximum possible cutoffs.

Exams: There will be two exams, a midterm and a final, each worth 15% of your grade. Exams will test your understanding of the material covered in lecture and the activities performed in the homework. In general, exam questions will be at the undergraduate level. Graduate students should expect to be asked to provide more detailed answers or to answer additional questions at a higher level. The final exam will be held on Thursday, December 14th from 3:00-5:00pm.

Project: Students will be responsible for completing a professional-style research project by the end of the semester that will be worth 30% of the course grade. You will propose project ideas individually, and then work in small groups to obtain, process, and analyze archival telescope data using the techniques covered in lecture. Each group will give an oral presentation of their project during class. Presentations will be made in class the week of December 2. Groups will be a mix of undergraduate and graduate students. Undergraduates will be expected to generate a AAS-style research poster to be used during the oral presentation. Graduate students will be required to write and submit a research journal-style paper in addition to the oral presentation.

Quiet Classroom and Classroom Etiquette Policy: Please be respectful of both the instructor and your fellow students. Avoid causing any distractions that could disrupt the ability of another student to pay attention and learn in class. All electronic devices should be muted, silenced, or

turned off before class begins. Please refrain from using any electronic devices in class (laptops, tablets, phones, etc.) unless you are using them to take notes ONLY. Do not talk during class while I am talking. If you are holding a conversation and disrupting the class, I will ask you to stop and make note of the disruption. I reserve the right to drop repeated offenders (3+ incidents) from the course.

Students with Disabilities: Students requesting accommodations for this course due to a disability must go through Accessibility Services (Mesa Vista Hall 2021, 505-277-3506).

Academic Integrity: From the UNM Handbook: "Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in course work may receive a reduced or failing grade for the work in question and/or for the course.
Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or without the University; and nondisclosure or misrepresentation in filling out applications or other University records."

Title IX: In an effort to meet obligations under Title IX, UNM faculty, Teaching Assistants, and Graduate Assistants are considered "responsible employees" by the Department of Education (see pg 15 - http://www2.ed.gov/about/offices/list/ocr/docs/qa-201404-title-ix.pdf). This designation requires that any report of gender discrimination which includes sexual harassment, sexual misconduct and sexual violence made to a faculty member, TA, or GA must be reported to the Title IX Coordinator at the Office of Equal Opportunity (oeo.unm.edu). For more information on the campus policy regarding sexual misconduct, see: https://policy.unm.edu/university-policies/2000/2740.html.

TENTATIVE COURSE SCHEDULE

Week	Dates	Topics
1	Aug 19, 21	Course overview; radiation fundamentals
2	Aug 26, 28	Radiometry; Python/Astropy
3	Sept 2, 4	Image formation, telescope design
4	Sept 9, 11	Optical telescopes
5	Sept 16, 18	Detectors overview
6	Sept 23, 25	Statistics, noise, and error analysis
7	Sept 30, Oct 2	Discussion of Project, Review; **Mid-term Exam**
8	Oct 7, 9	Analysis of Sequential Data
9	Oct 14, 16	Project Proposal Due; Fourier Transforms
10	Oct 21, 23	Optical/IR
11	Oct 28, 30	Data modeling
12	Nov 4, 6	Spectroscopy
13	Nov 11, 13	Submillimeter and radio
14	Nov 18, 20	Interferometry
15	Nov 25, 27	Final Projects Due; Multi-messenger astronomy
16	Dec 2, 4	Student project presentations
17	Dec 10	**Final Exam**