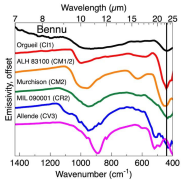
College of the Environment, Forestry, and Natural Sciences



AST 530: Topics in Astronomy (Applications in Spectroscopy)

College of Environment, Forestry, & Natural Sciences
Department of Astronomy & Planetary Science
Semester: Spring 2023
Prerequisites: None
Location: Physical Sciences (Building 19), Room 111
Meeting Time & Format: Monday & Wednesday 12:45-2:00pm (3 credits, Letter Grade Only)
Instructors: Dr. Christopher Edwards, christopher.edwards@nau.edu, (928) 523-7234
Office Hours: Dr. Edwards: Mondays 11:45am-12:45pm or also by appointment.

Course Purpose

This course will discuss the fundamental principles of spectroscopy in the context of laboratory work, observational astronomy, and planetary science. The course will take a quantitative perspective on spectroscopy using foundational wave equations, light interactions with materials, details of instrumentation and spectroscopic methods, as well as applications to laboratory studies and planetary science.

Course Description

This course is a lecture-based course that meets for three hours per week to discuss the fundamental principles outlined above and to develop the analytical tools to apply these principles to various scientific problems. These topics will be introduced in class and supplemented with assigned readings that support the course lectures. These readings will be assigned weekly from outside materials. Homework sets will be assigned to explore spectroscopic principles and to provide practice in their application. In the first half of the semester, students will develop a short proposal on a topic related their interests that is relevant to spectroscopy. Students will work with the instructor to develop a topic suitable for the proposal. In the latter half of the course, students will examine how to apply spectroscopic instruments to current research questions and will develop a spectrometer instrument concept proposal.

Course Objectives & Learning Outcomes

The primary objectives of this course are to develop a quantitative understanding of the governing fundamental principles of spectroscopy and to develop the tools to apply these principles to particular problems of scientific interest. This course will be broken out into several topics. In general, this course will move from a more theoretical discussion to measurement techniques and applications.

By the end of the semester, students will be able to:

- Quantitatively describe the interaction of electromagnetic waves with materials and Maxwell's equations
- Understand how spectroscopy works and how it can be used over the electromagnetic spectrum (e.g. gamma, x-ray, visible, infrared)
- Discuss the limitations and applications of spectroscopic modeling (Hapke, unmixing, etc.)
- Describe (at a high level) the basic functions of and differences in instrumentation and spectroscopy methods (FTIR, grating, Raman, etc.)
- Discuss applications of spectroscopy in the lab, across the solar system, and through telescopic observations (e.g. spectroscopy of planetary surfaces, interpretation, etc.)
- Develop proposals from conception to completion

Assessment

Course assessment will include homework, class participation, the research proposal components (outline, proposal), instrument proposal (outline, proposal, presentation)

Homework (3 assignments, 50 pts each)	150	90% and above	A
Class Participation	50	80 - 89%	B
Research Proposal Outline	50	70 - 79%	C
Research Proposal	100	60 - 69%	D
Research Proposal Peer Review	50	59% and below	F
Instrument Concept Proposal Outline	50		
Instrument Concept Proposal	200		
Instrument Concept Proposal Presentations	50		
	700 Total		

Homework: The homework assigned in this course will primarily cover the applications of spectroscopic methods. These homework assignments are focused on theory and application of spectroscopic methods. The application focused homework can be completed in the programming language of the student's choice but all code must be submitted with the assignments.

Class Participation: Active class participation (engaged in discussions, examples from reading and research, etc.) will be used to assess this portion of the student's grade.

Research Proposal: A short proposal focusing on your area of research interest (telescope/spacecraft/lab, solar system/stars/galaxies) where you will conceive of a research topic, describe its scientific importance, methodology and expected outcomes. The proposal is not intended to focus on your specific ongoing research projects. This proposal will start with an outline developed with feedback from the instructors. Research proposals will also be peer reviewed (~2-3 reviews per proposal) with a provided review template.

Instrument Concept Proposal: An instrument concept focusing on developing an instrument that would be useful for your area of research interest. In this proposal, you will conceive of an instrument to make needed measurements to address specific scientific questions. The proposal must justify the scientific basis, instrument performance details, and feasibility. Like the research proposal, an outline will be developed first. The concepts will be presented to the class (~10 minutes) at the end of the semester.

Reading Assignments: Reading assignments will be given out prior to the start of each topic, as necessary. There will generally be one or two readings per topic that will be taken from an outside source (i.e., Journal article) that will be provided. These readings are designed to augment the discussion in class and as such should be completed prior to the day in which the material will be covered.

Course effort: At a minimum, you should plan on spending an additional 5-10 hours per week on this class outside of our scheduled meeting times. In addition to formal assignments you should also review what we have covered previously and looking ahead to what is coming.

Suggested Materials & Technology

These materials are available in the NAU library.

- *Suggested: Mineralogical Applications of Crystal Field Theory, by Burns*
- *Suggested: Symmetry and Spectroscopy, by Harris*

Class Schedule:

The most up to date class schedule and materials can be found under the Shared Google Drive Folder: https://drive.google.com/drive/folders/14ywJnPUfqvZLXit3HTttuuQmOrGOkJaA?usp=sharing

Class, Departmental, & University Policies

- As a courtesy to the instructors and to your fellow students, please come to class on time.
- All assignments are due at 5pm MST on the specified date. Students are expected to complete all assignments on time. Any requests for additional time need to be submitted to both instructors at least 2 days in advance and need to be adequately justified.
- Please use the zoom video when available and mute your microphone when appropriate. Please refrain from any other "electronic distractions" (e.g., answering emails, text messaging, browsing social media) during class. If you are anticipating disruptions during class for any personal or professional reasons, please notify the professor prior to class.
- Please disclose any disabilities or special requirements to the NAU Disabilities Resources Office, who will contact the instructors privately regarding any accommodations.
- Neither audio nor video recording will be permitted except under special circumstances prescribed by the NAU Disability Resources Office or discussed with the professor prior to class. Due to the COVID-19 pandemic the professors may choose to record the online course.

Northern Arizona University Policy Statements

COVID-19 REQUIREMENTS AND INFORMATION

Additional information about the University's response to COVID-19 is available from the **Jacks are Back!** web page located at https://nau.edu/jacks-are-back.

SYLLABUS POLICY STATEMENTS

ACADEMIC INTEGRITY

NAU expects every student to firmly adhere to a strong ethical code of academic integrity in all their scholarly pursuits. The primary attributes of academic integrity are honesty, trustworthiness, fairness, and responsibility. As a student, you are expected to submit original work while giving proper credit to other people's ideas or contributions. Acting with academic integrity means completing your assignments independently while truthfully acknowledging all sources of information, or collaboration with others when appropriate. When you submit your work, you are implicitly declaring that the work is your own. Academic integrity is expected not only during formal coursework, but in all your relationships or interactions that are connected to the educational enterprise. All forms of academic deceit such as plagiarism, cheating, collusion, falsification or fabrication of results or records, permitting your work to be submitted by another, or inappropriately recycling your own work from one class to another, constitute academic misconduct that may result in serious disciplinary consequences. All students and faculty members are responsible for reporting suspected instances of academic misconduct. All students are encouraged to complete NAU's online academic integrity workshop available in the E-Learning Center and should review the full *Academic Integrity* policy available at https://policy.nau.edu/policy/policy.aspx?num=100601.

COPYRIGHT INFRINGEMENT

All lectures and course materials, including but not limited to exams, quizzes, study outlines, and similar materials are protected by copyright. These materials may not be shared, uploaded, distributed, reproduced, or publicly displayed without the express written permission of NAU. Sharing materials on websites such as Course Hero, Chegg, or related websites is considered copyright infringement subject to United States Copyright Law and a violation of NAU Student Code of Conduct. For additional information on ABOR policies relating to course materials, please refer to ABOR Policy 6-908 A(2)(5).

COURSE TIME COMMITMENT

Pursuant to Arizona Board of Regents guidance (ABOR Policy 2-224, *Academic Credit*), each unit of credit requires a minimum of 45 hours of work by students, including but not limited to, class time, preparation, homework, and studying. For example, for a 3-credit course a student should expect to work at least 8.5 hours each week in a 16-week session and a minimum of 33 hours per week for a 3-credit course in a 4-week session.

DISRUPTIVE BEHAVIOR

Membership in NAU's academic community entails a special obligation to maintain class environments that are conductive to learning, whether instruction is taking place in the classroom, a laboratory or clinical setting, during course-related fieldwork, or online. Students have the obligation to engage in the educational process in a manner that does not interfere with normal class activities or violate the rights of others. Instructors have the authority and responsibility to address disruptive behavior that interferes with student learning, which can include the involuntary withdrawal of a student from a course with a grade of "W". For additional information, see NAU's *Disruptive Behavior in an Instructional Setting* policy at https://nau.edu/university-policy-library/disruptive-behavior.

NONDISCRIMINATION AND ANTI-HARASSMENT

NAU prohibits discrimination and harassment based on sex, gender, gender identity, race, color, age, national origin, religion, sexual orientation, disability, veteran status and genetic information. Certain consensual amorous or sexual relationships between faculty and students are also prohibited as set forth in the *Consensual Romantic and Sexual Relationships* policy. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's *Nondiscrimination and Anti- Harassment* policy. EAO also assists with religious accommodations. For additional information about nondiscrimination or anti-harassment or

to file a complaint, contact EAO located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011, or by phone at 928-523-3312 (TTY: 928-523-1006), fax at 928-523-9977, email at equityandaccess@nau.edu, or visit the EAO website at https://nau.edu/equity-and-access.

TITLE IX

Title IX of the Education Amendments of 1972, as amended, protects individuals from discrimination based on sex in any educational program or activity operated by recipients of federal financial assistance. In accordance with Title IX, Northern Arizona University prohibits discrimination based on sex or gender in all its programs or activities. Sex discrimination includes sexual harassment, sexual assault, relationship violence, and stalking. NAU does not discriminate on the basis of sex in the education programs or activities that it operates, including in admission and employment. NAU is committed to providing an environment free from discrimination based on sex or gender and provides a number of supportive measures that assist students, faculty, and staff.

One may direct inquiries concerning the application of Title IX to either or both the Title IX Coordinator or the U.S. Department of Education, Assistant Secretary, Office of Civil Rights. You may contact the Title IX Coordinator in the Office for the Resolution of Sexual Misconduct by phone at 928-523-5434, by fax at 928-523-0640, or by email at titleix@nau.edu. In furtherance of its Title IX obligations, NAU promptly will investigate or equitably resolve all reports of sex or gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. The Office for the Resolution of Sexual Misconduct (ORSM): Title IX Institutional Compliance, Prevention & Response addresses matters that fall under the university's Sexual Misconduct policy. Additional important information and related resources, including how to request immediate help or confidential support following an act of sexual violence, is available at https://in.nau.edu/title-ix.

ACCESSIBILITY

Professional disability specialists are available at Disability Resources to facilitate a range of academic support services and accommodations for students with disabilities. If you have a documented disability, you can request assistance by contacting Disability Resources at 928-523-8773 (voice), ,928-523-8747 (fax), or dr@nau.edu (e-mail). Once eligibility has been determined, students register with Disability Resources every semester to activate their approved accommodations. Although a student may request an accommodation at any time, it is best to initiate the application process at least four weeks before a student wishes to receive an accommodation. Students may begin the accommodation process by submitting a self-identification form online at https://nau.edu/disability-resources/student-eligibility-process or by contacting Disability Resources. The Director of Disability Resources, Jamie Axelrod, serves as NAU's Americans with Disabilities Act Coordinator and Section 504 Compliance Officer. He can be reached at jamie.axelrod@nau.edu.

RESPONSIBLE CONDUCT OF RESEARCH

Students who engage in research at NAU must receive appropriate Responsible Conduct of Research (RCR) training. This instruction is designed to help ensure proper awareness and application of well-established professional norms and ethical principles related to the performance of all scientific research activities. More information regarding RCR training is available at https://nau.edu/research/compliance/research-integrity.

MISCONDUCT IN RESEARCH

As noted, NAU expects every student to firmly adhere to a strong code of academic integrity in all their scholarly pursuits. This includes avoiding fabrication, falsification, or plagiarism when conducting research or reporting research results. Engaging in research misconduct may result in serious disciplinary consequences. Students must also report any suspected or actual instances of research misconduct of which they become aware. Allegations of research misconduct should be reported to your instructor or the University's Research Integrity Officer, Dr. David Faguy, who can be reached at david.faguy@nau.edu or 928-523-6117. More information about misconduct in research is available at https://nau.edu/university-policy-library/misconduct-in-research.

SENSITIVE COURSE MATERIALS

University education aims to expand student understanding and awareness. Thus, it necessarily involves engagement with a wide range of information, ideas, and creative representations. In their college studies, students can expect to encounter and to critically appraise materials that may differ from and perhaps challenge familiar understandings, ideas, and beliefs. Students are encouraged to discuss these matters with faculty.

Last revised August 4, 2022