



## AST 530: Topics in Astronomy (Applications in Spectroscopy)

**College of Environment, Forestry, & Natural Sciences**

**Department of Astronomy & Planetary Science**

**Semester:** Spring 2021

**Prerequisites:** None

**Location:** Remote synchronous, NAUFlex

**Zoom:** <https://nau.zoom.us/j/83240392650>

Meeting ID: 832 4039 2650, Password: 285354

**Meeting Time & Format:** Monday & Wednesday 2:20-3:35pm (3 credits, Letter Grade Only)

**Instructors:** Dr. Cristina Thomas, [cristina.thomas@nau.edu](mailto:cristina.thomas@nau.edu), (928) 523-0294

Dr. Christopher Edwards, [christopher.edwards@nau.edu](mailto:christopher.edwards@nau.edu), (928) 523-7234

**Guest Instructor:** Dr. Lisa Prato, [lprato@lowell.edu](mailto:lprato@lowell.edu), (928) 233-3213

**Office Hours:** Dr. Thomas: Thursdays 11am-12pm

Dr. Edwards: Wednesdays 1:20-2:20pm

Both instructors are also available by appointment. All office hours will be held on zoom.

### 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 (4 assignments, 50 pts each)	200	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		
	<b>750 Total</b>		

**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.

**Suggested 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, readings, assignments, and syllabus can be found under the shared Google Drive: <https://drive.google.com/drive/folders/1-Gs4Jxut-LZmn70tUh3-LDgjp2PNfLNA?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**

**The following statements in red set forth in this document’s first section are specific to NAU’s response to the COVID-19 situation. The requirements outlined below are mandatory until further notice.** They are based upon current public health conditions and guidance and may change as circumstances warrant or new information becomes available. 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/lumberjack-responsibilities>.

### **FACE COVERING AND PHYSICAL DISTANCING REQUIREMENTS**

Appropriate face masks or other suitable face coverings must be worn by all individuals when present in classrooms, laboratories, studios, and other dedicated educational spaces. To maximize the benefits of physical distancing as an important strategy to help reduce community transmission of the SARS-CoV-2 virus, instructors may implement mandatory student seating arrangements or specific seat assignments. Instructors may remove students who do not cooperate with these requirements from the instructional space in the absence of an approved accommodation arranged through Disability Resources. Failing to comply with these requirements may constitute a violation of the university’s *Disruptive Behavior in an Instructional Setting* policy available at <https://nau.edu/university-policy-library/disruptive-behavior>.

### **USE NAUFLEX TO HELP MAINTAIN PHYSICAL DISTANCING**

NAUFlex (available at <https://nau.edu/nauflex/student>) is designed to help all students actively participate in their coursework during the required day and time of a course when they are not physically present in the classroom. This course design model allows students to be fully engaged with faculty and peers and receive the high-quality educational experience for which NAU is known.

### **CLASS SESSION RECORDINGS FOR STUDENTS AND FACULTY USE ONLY**

Certain class sessions may be audio or video recorded to help reinforce live instruction during the COVID-19 pandemic. These recordings are for the sole use of the instructor and students enrolled in the course. Recordings will be stored in approved, accessible repositories. By enrolling, students agree to have their image and classroom statements recorded for this purpose, to respect the privacy of their fellow students, and university-owned intellectual property (including, but not limited to, all course materials) by not sharing recordings from their courses. Questions regarding restrictions on the use of classroom audio or video recordings may be addressed to the appropriate academic unit administrator.

### **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>.

### **COURSE TIME COMMITMENT**

Pursuant to Arizona Board of Regents guidance (Academic Credit Policy 2-224), for every unit of credit, a student should expect, on average, to do a minimum of three hours of work per week, including but not limited to class time, preparation, homework, and studying.

### **DISRUPTIVE BEHAVIOR**

Membership in NAU's academic community entails a special obligation to maintain class environments that are conducive 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 breach the peace, 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 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, or veteran status. Due to potentially unethical consequences, certain consensual amorous or sexual relationships between faculty and students are also prohibited. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's Safe Working and Learning Environment (SWALE) policy. EAO also assists with religious accommodations. For additional information about SWALE 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](mailto:equityandaccess@nau.edu), or via the EAO website at <https://nau.edu/equity-and-access>.

## **TITLE IX**

Title IX is the primary federal law that prohibits discrimination on the basis of sex or gender in educational programs or activities. Sex discrimination for this purpose includes sexual harassment, sexual assault or relationship violence, and stalking (including cyber-stalking). Title IX requires that universities appoint a “Title IX Coordinator” to monitor the institution’s compliance with this important civil rights law. NAU’s Title IX Coordinator is Pamela Heinonen, Director of the Equity and Access Office located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011. The Title IX Coordinator is available to meet with any student to discuss any Title IX issue or concern. You may contact the Title IX Coordinator by phone at 928-523-3312 (TTY: 928-523-1006), by fax at 928-523-9977, or by email at [pamela.heinonen@nau.edu](mailto:pamela.heinonen@nau.edu). In furtherance of its Title IX obligations, NAU will promptly investigate and equitably resolve all reports of sex or gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. Additional important information about Title IX and related student resources, including how to request immediate help or confidential support following an act of sexual violence, is available at <http://nau.edu/equity-and-access/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), 928-523-6906 (TTY), 928-523-8747 (fax), or [dr@nau.edu](mailto: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](mailto: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>.

## **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.