Fall 2024

PHYS 780 - 001: Magnetosphere Physics

Lindsay Goodwin

Syllabus for PHYS 780
Remote Sensing for Space Weather Monitoring Purposes

L. V. Goodwin (they/them, she/her), Assistant Professor, Department of Physics

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E-mail:
lindsay.v.goodwin@njit.edu
Office:
Physical: Tiernan 101
Virtual:
https://njit-edu.zoom.us/j/4889512513?pwd=eHNOaVpuZFZ6SXB5Y3B3YTQvNlNzdz09
Office Hours:
Tiernan 101 - Tuesday from 10:30 AM - 12:00 PM (other times by appointment)
Tiernan 101 - Friday from 10:00 AM - 11:00 AM

Lecture: Faculty Memorial Hall 405
Tuesdays and Thursdays 1:00 - 2:30

Course Description

As we learn to live in space, understanding and detecting variations in space weather becomes more critical. This course will give a graduate level overview of remote sensing techniques from both a physics and engineering perspective. Further, although this course will focus on the space environment (including the ionosphere, magnetosphere, solar wind, sun, and heliosphere), a goal of this course will be to understand how the discussed techniques can be applied to different environments. This course will cover (but is not limited to) such instrumentation as multi-wavelength receivers (radio, optical/IR, to UV, X-rays, and gamma rays), radars (e.g. incoherent scatter radars and HF radars), interferometers, and spectrometers.

Learning Objectives

- Modern optics techniques:
  - **Explore active and passive modern optics techniques**: Understand the principles behind receivers, spectrometers, interferometers, radars, and polarimeters.
  - **Learn the principles of electromagnetic radiation as it pertains to space weather**: Explain how different wavelengths of electromagnetic radiation are used in detecting and understanding space weather events.

- Practical space weather monitoring:
  - **Explore remote sensing technologies used in modern space weather monitoring**: Identify and describe different remote sensing instruments and their roles in space weather observation.
  - **Interpret space weather data**: Analyze data from sensors to assess space weather and its potential impacts.
  - **Evaluate space-based and ground-based remote sensing techniques for space weather monitoring**: Compare the strengths and limitations of space-based vs ground-based sensors.
  - **Examine the development of future space weather remote sensing technologies**: Research emerging technologies and missions that are expected to advance our capabilities in space weather observation and forecasting.

Required Materials

- **Suggested Textbooks:**
  - Moldwin, M. (2022). *An introduction to space weather*. Cambridge University Press.
  - Froula, D., Glenzer, S. H., & Luhmann, Jr.(Neville C.). (2010). *Plasma Scattering of Electromagnetic Radiation* (Vol. 30). New York: Academic Press.
- **Canvas**: The syllabus and lecture material is on Canvas.

Prerequisites/Corequisites

Prerequisites: Be enrolled in a STEM NJIT graduate program.
Co-requisites: None

Grading Policy

Grades will be based on a term average for the semester's work that includes the exams, the final exam, and the term's homework score. The approximate weights to be used for calculating the term average score:

- **15%** for Exam 1 (24 hour take home exam, no calculator needed)
  - October 1, 1:00 PM - October 2, 1:00 PM
- **15%** for Exam 2 (24 hour take home exam, no calculator needed)
  - October 29, 1:00 - October 30, 1:00 PM
- **15%** for Exam 3 (24 hour take home exam, no calculator needed)
  - November 26, 1:00 - November 27, 1:00 PM
- **20%** for the Comprehensive Final Exam (48 hour take home exam, no calculator needed)

  - During Finals Week, 48 hours long
- **35%** for Homework

The term average values used as cutoffs for various letter grades will be in the approximate range of: 85% for A, 80% for B+, 70% for B, 65% for C+, 55% for C, and 50% for D and $< 50\%$ for F.

There will normally be no make-up exams. Students who miss an exam usually receive a score of zero for that exam. Students who expect to be absent from an exam should discuss their situation with their instructor PRIOR TO their absence. In order to qualify for a (rare) "make-up" exam, a student needs to document the reason for not being able to take the test as scheduled. Under NJIT standard policy, the documentation should be presented to the instructor AND to the Dean of Students. BOTH the instructor and the Dean of Students must concur in permitting a "make-up" Exam. Students who miss exams and do not contact and present documentation to their instructor within 7 days of the Exam will receive a score of zero for the Exam.

Withdrawal:

If you must withdraw from the course, do it officially through the Registrar before the last withdrawal date. If you simply stop attending and stop taking exams, your instructor will have no option other than to assign a course grade of "F".

Honor Code Violations:

NJIT has a zero-tolerance policy for cheating of any kind and for disruptive student behavior. Violations will be reported to the Dean of Students. The penalties range from a minimum of failure in the course plus disciplinary probation up to expulsion from NJIT. Avoid situations where your own behavior could be misinterpreted as dishonorable.

General Class Expectations:

- Students are required to agree to the NJIT Honor Code at all times.
- College Rule of Thumb: You should expect to spend a minimum of 2 hours in outside work for each hour spent in class each week. That means 6 hours outside of lecture spent on this class alone.
- You should expect to be assessed on learning outcomes by means of three exams, a final exam, and scores on homework assignments.
- Do not create distractions in class that interfere with the work of other students or instructors.
- Electronic recording devices are permitted as long as they are not disruptive to the class. Please refrain from using electronics for anything but class related activities.
- The schedule below lists the topics covered and text readings. Do the homework problems: it is almost impossible to succeed in physics courses without working on a lot of problems.

Academic Integrity

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working

on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: NJIT Academic Integrity Code.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at `dos@njit.edu`"

Generative AI

The usage of artificial intelligence (AI) is permitted in this course and no citation is necessary. If you have any questions or concerns about AI technology use in this class, please reach out to your instructor prior to submitting any assignments.

Approximate Schedule

Date	**Topic**	**Additional Notes**
Sept 3 - 5	Radio (Passive)	Introduction to class and settling in
Sept 10 - 12	Radio (Passive)	Homework 1 due Sept 12 **Remote Class Sept 10 - 12**
Sept 17 - 19	Radio (Active)	Homework 2 due Sept 19
Sept 24 - 26	Radio (Active)	Homework 3 due Sept 26
Oct 1, 1 PM - Oct 2, 1 PM	**EXAM 1**	
Oct 1 - 3	Microwave	Homework 4 due Oct 3 **Recorded lecture for Oct 3**
Oct 8 - 10	Microwave	Homework 5 due Oct 10
Oct 15 - 17	Infrared	Homework 6 due Oct 17
Oct 22 - 24	Visible	Homework 7 due Oct 24
Oct 29, 1 PM - Oct 30, 1 PM	**EXAM 2**	
Oct 29 - 31	Visible	Homework 8 due Oct 31
Nov 5 - 7	UV	Homework 9 due Nov 7
Nov 12 - 14	UV	Homework 10 due Nov 14
Nov 19 - 21	X-ray	Homework 11 due Nov 21
Nov 26, 1 PM - Nov 27, 1 PM	**EXAM 3**	
Nov 26 - 28	X-ray	**No Homework due** **No class Nov 28 (Thanksgiving)**
Dec 3 - 5	Gamma/Magnetometers	Homework 12 due Dec 5
Dec 10	Magnetometers/Summary	Homework 13 due Dec 10 **Final Class/Recorded lecture**
TBD	**FINAL EXAM**	

Remote classes occur here (Prof Goodwin's Zoom Room):
https://njit-edu.zoom.us/j/4889512513?pwd=eHNOaVpuZFZ6SXB5Y3B3YTQvNlNzdz09