

Week 1: Introduction to Electromagnetic Waves

Objective

Introduce students to the fundamental concepts of electromagnetic waves, their properties, using engaging question of Search for Extraterrestrial Intelligence (SETI) and hands-on lab involving GNU Radio.

Day 1: Search for Extraterrestrial Intelligence (SETI)

- Open with the big question.
 - Philosophical perspectives on the question "are we alone in the universe?".
 - Scale of the universe and our place in it.
 - The role of SETI in seeking the answer.
- Introduction to SETI.
 - Core principles and objectives of SETI.
 - Drake equation.
 - Overview of the methods and technologies used in SETI.
 - Highlight some of the most promising SETI projects and discoveries to date.
- Interactive discussion on imagining extraterrestrial life.
 - Invite students to share their views on the possibility of extraterrestrial life.
 - Drake equation worksheet.
 - Discuss the implications of discovering extraterrestrial intelligence; what would it mean for humanity?
 - Encourage students to think about what forms extraterrestrial life might take and how we might communicate with them.

- Wrap-up and preview of Day 2.
- Set the stage for a deeper dive into the fundamentals of electromagnetic waves which serve as the backbone of SETI search methods.

Day 1 Teaching Resources

- Scale of the Universe Interactive.
- Universe Size Comparison Video.
- Research at the SETI Institute.
- Drake Equation Worksheet - MNSU.
- Drake Equation Explanation - UMD.

Day 2: The Electromagnetic Spectrum

- Introduction.
 - Connection to SETI.
 - Briefly recap Day 1 and emphasize the role of electromagnetic waves in SETI.
- The electromagnetic spectrum.
 - Basic definition of electromagnetic waves.
 - Overview of the EM spectrum (radio waves, microwaves, infrared, visible, ultraviolet, x-rays, gamma rays).
 - Importance in communication and technology.
- Electromagnetic wave fundamentals.
 - Speed of light in vacuum and different media.
 - Wavelength and frequency.
 - Amplitude.
 - Phase.
 - Polarization.
- Generation and detection of EM waves.
 - Antennas and oscillators.

- Radio telescopes and detectors.
- Applications in SETI.
 - Role of radio waves in communication with potential extraterrestrial life.
 - Ongoing SETI research involving radio waves.

Day 2 Teaching Resources

- Anatomy of an Electromagnetic Wave - NASA
- Electromagnetic Spectrum
- Electromagnetic Spectrum Slides
- Properties of Electromagnetic Radiation.
- Antenna Fundamentals
- Finding Artificial Signals - Berkeley SETI.
- SETI Observations- SETI Institute.

Day 3: Introduction to Software Defined Radio (SDR) and GNU Radio

- Software defined radio.
 - Introduce the need for signal processing in radio communications.
 - Overview of traditional radio and the circuitry involved in signal processing.
 - Overview of software defined radio and its benefits.
 - Brief intro to analog-to-digital conversion (ADC).
- Conceptual foundation of waveform generation.
 - Brief overview of waveforms.
 - Importance in signal processing.
- GNU Radio.
 - Introduce the GNU Radio toolkit.
 - Tutorial on installing GNU Radio software.
 - Overview of blocks and connections in GRC.

- GRC demonstration: generating and visualizing different types of waveforms (sine, square, triangle, etc.).
- Simulated SETI signal demo.
 - Generating simulated radio signals.
 - Visualizing and analyzing the signal.
- Conclusion, Discussion, and Day 3 Recap.

Day 3 Teaching Resources

- Traditional Radio Receiver Circuitry
- Software Defined Radio
- Analog to Digital Conversion
- Intro to GNU Radio
- GNU Radio Tutorials