# ECE4804: LIDAR System Fundamentals (3-0-0-3)

Spring 2024


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| **Instructor:** | Christopher R. Valenta, Ph.D., P.E. | **Time:** | T/R 1700-1815 |
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Please note that this syllabus is a living document and pieces of it may change as the semester progresses. Announcements will be made in class and via e-mail.

**Office Hours:** Tuesdays 1100-1200 and by appointment

**Prerequisite:** ECE3025 or Instructor Approval.

**Description:**
Although LIght Detection And Ranging (LIDAR) systems have been around since the invention of the laser, these instruments have seen remarkable development and deployment in the past decade. From their use as part of the sensor suite for autonomous vehicles for navigation, to their use as an authentication mechanism for smart phones and tablets, and to their use as remote sensing instruments to help forecast weather and provide data for climate change research, LIDAR data products provide outstanding situational awareness for their users. This course provides an introduction to the fundamentals and the theory of LIDAR; their major components; optical, electrical, and mechanical performance analysis; applications; and data products.

**Course Outcomes:**
At the end of the course, a successful student should be able to:

1. explain how a LIDAR system operates and identify major components;
2. analyze the performance of a LIDAR system and identify engineering tradeoffs;
3. describe the different types of LIDARs and their applications;
4. understand the interdisciplinary engineering design process;
5. and process basic LIDAR data and create fundamental data products.

**Student Outcomes:**
In the parentheses for each Student Outcome: "P" for primary indicates the outcome is a major focus of the entire course. "M" for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material. "LN" for "little to none" indicates that the course does not contribute significantly to this outcome.

1. ( P ) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. ( LN ) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. ( LN ) An ability to communicate effectively with a range of audiences
4. ( M ) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. ( LN ) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. ( M ) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. ( LN ) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

**Required Materials:**

- Paul McManamon, "LiDAR Technologies and Systems," SPIE Press, Bellingham, WA, 2019. (Freely available through SPIE while on campus VPN)
- Richard D. Richmond and Stephen C. Cain, "Direct-Detection LADAR Systems," SPIE Press, Bellingham, WA, 2009. (Freely available through SPIE while on campus VPN)

**Reference Materials:**

- "Active Electro-Optical Systems," 2nd Edition, Ed. Clifton S. Fox, SPIE Press, Bellingham, WA, 1996.
- "Laser Remote Sensing," Eds. Takashi Fujii and Tetsuo Fukuchi, CRC Press, Boca Raton, FL, 2005.
- Various publications will be provided on Canvas.

**Software:** We will be using Python in this course along with the NumPy, SciPy libraries. You may use MATLAB as well if you prefer.

**Course Page:** `https://canvas.gatech.edu` Check Canvas on a daily basis. Lecture slides, assignments, quizzes, and exams materials are posted on Canvas.

## Course Policies:

- The Georgia Tech Academic Honor Code applies to all work submitted in this course. To review the Honor Code, please visit `http://osi.gatech.edu/content/honor-code`.
- Students with disabilities who require reasonable accommodations to participate fully in the course activities or meet course requirements are encouraged to register with the office of Student Disability Services `http://disabilityservices.gatech.edu/`.
- Class attendance is highly recommended to fully and completely learn and absorb course materials. You are expected to work with your classmates to makeup missed lecture materials.
- You are expected to check your email daily.

- Please take a moment to review the 'Student-Faculty Expectations' document here: http://www.catalog.gatech.edu/rules/22.php.
- Anything turned late will result in a 10% penalty per day. If you foresee an issue, please contact me ahead of time.

**Grade Distribution:**

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| Homework (6) | 25% |
| Exams (2 @ 20% each) | 40% |
| Term Paper | 10% |
| Final | 25% |

**Letter Grade Distribution (by total points):**

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| 100 - 90 | A |
| <90 - 80 | B |
| <80 - 70 | C |
| <70 - 60 | D |
| <60 | F |

**Homework**: While you may work together on homeworks, submitted work must be entirely your own. When applicable, source code as well as outputs must be included.

**Exams:** No make-up exams will be given. If you have a properly documented case in which you miss an exam, the next exam will count for those missed points.

**Term Paper**: The term paper is designed to resemble an IEEE journal submission and allow students to do a deep dive into a relevant, LIDAR-related topic of their choosing. See Canvas for a more detailed description.