CPE 470/670 Fall 2025
Midterm Exam

Instructor: Parikshit Maini   Submission Deadline: 11:59 pm Wednesday, October 29, 2025

All text answers must be written using latex and submitted as a pdf document. Handwritten or scanned submissions will not be accepted and will not be graded. All code must be written in Python. Submit individual python files for every question. Zip together all submission material and submit the Zip folder. Question 1-3 is required for everyone. Question 4 is optional for CPE 470 students and is **required** for CPE 670 students. CPE 470 students can attempt question 4 for bonus points.

Your submission to this exam must be your own work. You are not permitted to collaborate with other students on the exam, seek help from other people or AI based tools. You are permitted to refer to class notes, lecture materials, books and other online teaching resources.

You are not permitted to use existing library implementations to perform the intended task in each question. If you have questions about a library functions usage for the exam, please ask the instruction team.

You are given the data from a LiDAR mounted on a robot placed in a rectangular room, with an opening in one of the walls as shown in the figure. You are given the data (in file lidar_data.csv) in polar coordinates in a CSV file with each line corresponding to an angle (degrees) and range (cm). The LiDAR has an orthogonal frame of reference. The origin of the frame of reference is located at the LiDAR center.
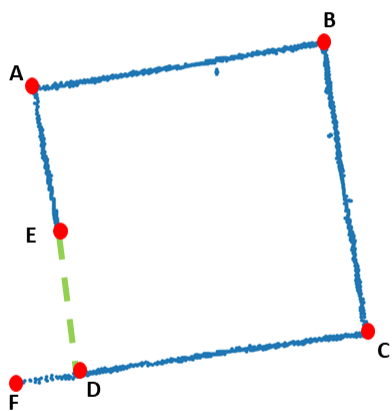

Figure 1: LiDAR datapoints are shown in blue. ABCD forms the rectangular room and DE is the opening out of the room. Point F is outside the room.

Question 1 (5 points): Write a Python script that reads the CSV and converts the data to Cartesian form. Assume that the value of the x-coordinate of the datapoints is known perfectly and sensor range measurement noise only exists in the y-coordinate. The lidar ranging accuracy is ±20mm.

Question 2 (20 points):
2a: Write a Python script to find the location of the points A, B, C, E and F shown in the figure. Print the point coordinates from your code (10 points). (Hint: When traversed in an angular ordering, range values will have an inflexion point at corners.)
2b: Explain your logic and calculations in text (10 points).

Question 3 (20 points):
3a: Write a Python script to find the equations of lines representing the four sides of the room using least squares algorithm taught in class. Use the cartesian coordinate form of lidar data generated in Question 1. Print the corner coordinates (points shown as A, B, C and D in the figure) and line equations from your code (10 points). (Hint: Corners can be used to separate the data into cluster correponding to each side of the room. You can use the intersection of lines to find the corner D.)
3b: Explain your logic and calculations in text (10 points).

[Required for CPE 670, Optional for CPE 470] Question 4 (25 points):
4a: Write a python script that identifies the opening DE in the room and prints the coordinates of the corners of the opening, D and E (10 points). (Hint: corner points of the opening will have large separation than other points)
4b: Also compute and print the width of the opening (5 points).
4c: Explain your logic and calculations in text (10 points).