Semester 1, 2025 Autonomous Driving Capstone Design Final Assessment Rulebook

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Future-car Bootcamp Center

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1. Competition Rules

Article 1 Purpose

• The purpose of these rules is to ensure the fair and efficient operation of the Autonomous Driving Competition organized by the Autonomous Driving Capstone Design Course.

Article 2 Eligibility

• Undergraduate students erolled in the Autonomous Driving Capstone Design course.

Article 3 Detailed Rules

- The detailed rules provide information on driving time, missions, scoring methods.
- The determination of penalties for each mission is at the sole discretion of the judges. Any objections to a decision may be raised after the race in accordance with the rules. However, objections must be submitted only within the designated time period on the day of the event.
- Each team is responsible for procuring and preparing their own vehicle and the necessary components in advance, in accordance with the competition's technical specifications.

2. Detailed Rules

2.1 Basic Rules

- The specified electric vehicle must autonomously drive on a track of given specifications, controlled exclusively by its onboard software and without any human intervention or other auxiliary devices.
- The vehicle must compete in all events in the same state as it was configured during the technical inspection. Re-installation or reconfiguration between missions is not permitted.
- The Time Tiral and the Mission races will be held separately. The final ranking is determined by the sum of the scores obtained in each event.
- The Mission race is conducted in two parts: the Obstacle Avoidance/Crosswalk (Traffic Light) Mission and the Parking Mission.
- A total of 15 minutes is allocated as follows: 4 minutes for the Time Trial, 7 minutes for the Obstacle Avoidance/Crosswalk Mission, and 4 minutes for the Parking Mission. Each team is allowed only one attempt per race. However, for the Time Trial, one restart may be permitted within the first minute of starting, without stopping the official timer.
- For the Mission races, no extra time will be provided for uploading or modifying programs (including parameters). Teams must proceed immediately according to their assigned order.
- Start and Stop Procedure: After the start signal is given, the team leader must start the vehicle by pressing any key on the laptop, beginning with the motor in a stopped state. The vehicle must be stopped by the same method upon mission completion. The use of remote controls is not permitted. Activating the motor before the start signal is not permitted.
- Once a mission begins, all operational decisions—including starting, stopping, repositioning, and retrying—are made by the team leader. For repositioning, team members may collectively move the vehicle to a designated position.
- During the parking mission, all participants must remain outside the designated gray area.
- A maximum of 3 participants per team are allowed on the track.

2.2 Time Trial Race

- Autonomous vehicles must complete two laps of the track.
- The starting position is designated as the outer lane (Lane 2) opposite the crosswalk section. The frontmost part of the vehicle, including sensors, must not cross the starting

line.

- Vehicles must drive counter-clockwise along the outer lane. Upon reaching the crosswalk section (after completing 0.5 laps from the start), they must change to the inner lane.
- Vehicles must then drive counter-clockwise along the inner lane. Upon reaching the crosswalk section again (after completing 1.5 laps from the start), they must change back to the outer lane.
- The vehicle must not cross any marked lanes on the track, with one exception: the center line within the zone between the thin lines preceding and succeeding the crosswalk. Any lane departure outside this exception may result in points deduction or disqualification according to penalty rules.
- The final recorded time will be calculated by measuring the total time taken to complete two laps, combined with any accumulated penalty time.
- If a judge determines that a lane departure has occurred, the judge will designate a repositioning point prior to the point of departure. The team members may then restart the vehicle from this designated position.
- The official timer will continue to run and include all time spent on retries and repositioning. If the 4-minute time limit is exceeded, the run will be stopped, and penalties will be assessed based on the uncompleted portion of the track.
- Rankings will be determined in ascending order of the final recorded time (lap time plus penalty time), from shortest to longest.
- During the Time Trial race, participants must remain behind their vehicle.
- To adjudicate lane departures, a judge will be monitoring the vehicle from behind. Teams must take in account for the judge's presence in their programming, objection based on sensor measurement errors potentially caused by the judge's proximity to the rear of the vehicle will not be accepted.

2.3 Mission Race

- The Mission is conducted in two parts: the Obstacle Avoidance/Crosswalk (Traffic Light) Mission and the Parking Mission.
- For the Obstacle Avoidance/Crosswalk (Traffic Light) Mission, the starting position is designated as the second lane (outer lane). The frontmost part of the vehicle, including any sensors, must not be positioned over the starting line.
- The obstacles for the Obstacle Avoidance Mission are defined as Obstacle Vehicle #1, #2, and #3, in order of proximity to the starting line.
- In the obstacle avoidance/crosswalk (traffic light) mission race, obstacle #3 is a vehicle that moves back and forth periodically in the obstacle avoidance zone.

- The Obstacle Avoidance/Crosswalk (Traffic Light) Mission must be performed in a single, continuous run, starting from the starting line, navigating the obstacles, and proceeding until the vehicle has completely passed through the crosswalk zone.
- To adjudicate obstacle collisions and lane departures, judges will monitor the vehicle from the gray and green areas outside the lanes. Teams must take in account for the judges' presence in their programming, objection based on sensor measurement errors potentially caused by the judges will not be accepted.
- The Crosswalk (Traffic Light) Mission may be attempted separately, in which case a 2-minute time limit is given. This is only permitted if the team did not spend more than 5 minutes in the obstacle avoidance section.
- The Parking Mission begins at the "IN" point, proceeds until parking is completed, requires the vehicle to remain stationary for at least two (2) seconds, and concludes when the vehicle exits the parking space and reaches the opposite "OUT" point.
- Penalty points will be assigned for any mission that is not attempted.
- A base score of 500 points is given to each team. Upon successful completion of each mission, the corresponding mission success points (as specified below) will be added. Penalty points for mission performance will be deducted from the base score, up to a maximum deduction limit.

| Mission | Parking | Obstacle Avoidance | Crosswalk | |
|---------|---------|--------------------|-----------------|--|
| | | | (Traffic Light) | |
| Point | 200 | 200 | 100 | |

2.4 Autonomous Vehicle Technical Regulations

- Only the vehicle model specified by the competition organizers must be used.
- All sensors, batteries, and motors must conform to the parts and specifications provided by the competition organizers.
- The placement of any sensor must not cause the vehicle's total dimensions to exceed 110 cm in length (front-to-back), 60 cm in width (left-to-right), or 75 cm in height.
- Teams are permitted to manufacture and install jigs for mounting vehicle sensors within the specified limits.
- Modifications to the vehicle are not permitted, with the exception of sensor attachments and cosmetic alterations for design purposes.

2.5 Evaluation

- Rankings will be determined separately for the Time Trial and Mission races.
- If the Mission scores are tie, the ranking will be decided by the team with the shorter completion time for the Parking Mission (This excludes cases where the Parking Mission was failed).
- Final rankings will be determined by the highest combined rank (Time Trial rank + Mission race rank).
- If combined ranks are tie, the team with the higher rank in the Mission race will be given the higher rank.

2.6 Inspection

- Teams must conduct a self-inspection using the provided checklist, then have them verified by the judges.
- An inspection will be performed before the main competition. Vehicles found to violate regulations (e.g., regarding parts used or sensor installation location) will be disqualified. However, if modifications can be made within 30 minutes, one re-inspection opportunity will be provided.
- Top-ranking vehicles will undergo a detailed inspection after the competition.

2.7 Objections

- Only after all races have concluded, team leaders may submit objections regarding rulings to the Race Operations Committee, and only during the designated objection period.
- Objections can only be raised concerning rulings made during the race, and the exact timing of the disputed ruling must be specified in the objection.
- Objections are limited to matters concerning one's own team and cannot be made regarding other teams.

3. Measurement of Driving Time

3.1 Time Trial Race Time Measurement

- The elapsed time is measured from the moment the start signal is given until the frontmost part of the vehicle (including any sensors) crosses the starting line again after completing two (2) laps.
- The vehicle must be positioned behind the starting line and must be started remotely (including via a laptop control key) upon the judge's official start signal.
- If the driving time exceeds the 4-minute limit, the race will be stopped, and the distance

completed will be recorded to determine the final score.

• The final record is the time taken to complete two laps plus any added penalty time.

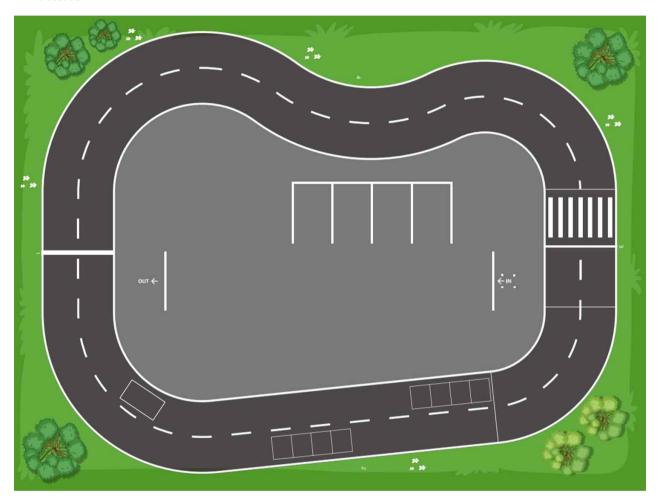
3.2 Mission Race Time Measurement

- Once the mission race begins, no extar time will be provided for program uploads or modifications (including parameters); proceedings will commence immediately according to the sequence. The mission race will be performed for a total of 11 minutes.
- Exceeding the 4-minute time limit to complete the Parking Mission will result in a mission failure.
- Teams that fail the obstacle avoidance Mission may still attempt the Crosswalk (Traffic Light) Mission separately, but only if their attempt on the obstacle Mission did not exceed 5 minutes. Exceeding this 5-minute limit on the obstacle Mission results in a failure for the entire Obstacle Avoidance/Crosswalk mission.

4. Track and Mission

4.1 Track Diagram

• The track consists of straight and curved lanes, and a parking zone is located in the center.



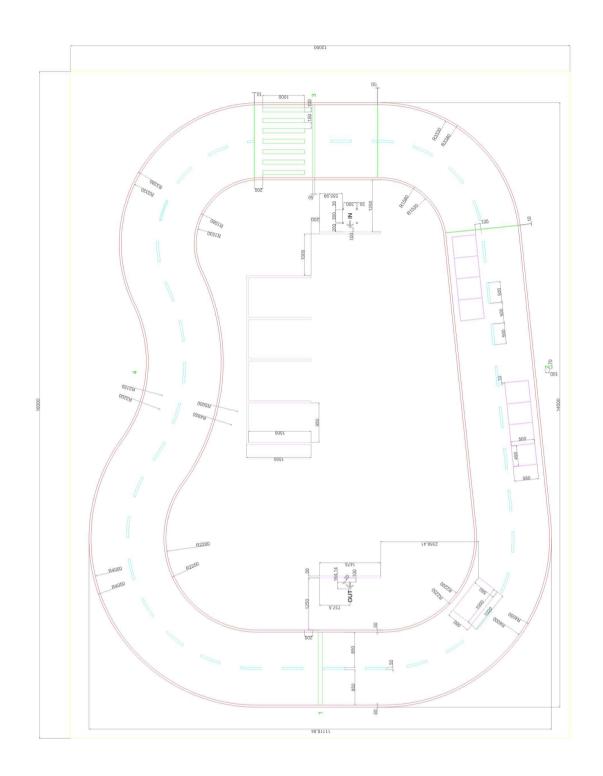
• The key dimensions are as follows:

- Lane width: 850mm

- Line width (solid and dashed lines) 목: 50mm, Starting line width: 100mm

- Crosswalk: 1000mm x 100mm

- Parking area: 950mm x 1500mm



4.2 Starting Line

• The vehicle must be stationary behind the starting line. When the start signal is given, the team leader shall start the vehicle by pressing a key on the laptop. Activating the motor before the official start signal is not permitted.

4.3 Lanes

• The track features white lane markings that imitate those of a standard road. It consists of two lanes, and vehicles must travel counter-clockwise along the designated path. Crossing the center line will result in a penalty, except within the designated lane-change zones of the Time Trial or during the obstacle avoidance mission.

4.4 Parking Zone

- A mission zone where the vehicle must park in a space between two other parked vehicles.
- The parking zone contains two available parking spaces. One space will be selected for use on the day of the competition.
- The mission starts from the line nearest to the traffic light. The specific starting position for each team will be determined by a random drawing of one of four possible locations.
- The starting position will be selected via a random drawing on the day of the competition. The designated starting marker (a 3 cm square) must be aligned directly under the centerline of the vehicle's front-right wheel. The marker must not protrude to the side of the wheel. No program modifications are permitted after the vehicle has been positioned.
- A parking attempt is judged as successful only if all wheels (both front and rear) are positioned completely inside the designated parking space lines.
- The mission is considered successful if, within the 4-minute time limit, the vehicle performs a perpendicular reverse park, remains stationary for at least two (2) seconds, exits the space, and its front wheels cross the designated 'OUT' line.
- The parking mission must be performed using the vehicle's steering mechanism. Rotational parking using only differential drive (a 'point turn') is not permitted.
- The maximum penalty score for this mission is 200 points.

4.5 Obstacle Avoidance Zone

- There are a total of three (3) obstacle vehicles. The vehicle models and colors may vary and will be determined and announced by the competition organizers in advance.
- Obstacle #1 is stationary at a fixed point in the first lane (inner lane).

- Obstacle #2 is stationary at a fixed point in the second lane (outer lane) on a straight section of the track.
- Obstacle #3 moves back and forth within the first lane (inner lane) on a straight section of the track.
- In the event of a collision with Obstacle #1, a penalty will be assessed, and the autonomous vehicle will be repositioned at the starting point.
- In the event of a collision with Obstacle #2 or Obstacle #3, a penalty will be assessed, and the autonomous vehicle will be repositioned in the second lane (outer lane) adjacent to Obstacle #1.
- If a collision occurs with both Obstacle #2 and Obstacle #3 simultaneously, only a single penalty for the collision will be assessed.
- If any lane departure (including crossing the center line) occurs before the vehicle passes the extended 'OUT' line of the nearby parking zone, the autonomous vehicle will be repositioned at the starting point.
- If any lane departure (excluding the center line) occurs after the vehicle has passed the extended 'OUT' line of the nearby parking zone, the autonomous vehicle will be repositioned in the second lane (outer lane) adjacent to Obstacle #1.
- The starting position is designated as the second lane (outer lane), and the frontmost part of the vehicle (including any sensors) must not be positioned over the starting line before the start signal.
- Crossing the center line within the designated obstacle avoidance zone does not result in a penalty.
- The mission is considered successful when the frontmost part of the vehicle (including any sensors) crosses the finish line of the obstacle avoidance zone.
- The maximum penalty score for this mission is 200 points.

4.6 Crosswalk (Traffic Light) Zone

- The vehicle must come to a stop before the crosswalk and shall only restart after the traffic light changes to green.
- When approaching a crosswalk, the traffic light is always red, and after stopping, the referee manually changes it to green at a random time.
- The mission is considered successful if the vehicle stops appropriately within the designated zone before the crosswalk, restarts in accordance with the signal, and its front wheels subsequently cross the finish line.
- The maximum penalty score for this mission is 100 points.

4.7 Lane Change Zone in the Time Trial

- This zone is the area located between the thin line preceding the crosswalk section and the thin line succeeding it.
- While proceeding counter-clockwise along the outer lane, the vehicle must perform a lane change into the inner lane within this zone (occurring at the 0.5-lap mark).
- While continuing counter-clockwise along the inner lane, the vehicle must perform a lane change back to the outer lane within this zone (occurring at the 1.5-lap mark).

5. Penalty

5.1 Time Trial Penalty

| 분류 | 코드 | 내용 | 페널티 |
|----------------------|----|--|-------------|
| | | -Failure to start within 10 seconds of the | Restart, |
| | a1 | start signal. (One restart attempt is | +30 |
| Start and | | permitted within the first minute). | seconds |
| Finish | | -Failure to complete 2 laps within 4 | +30 |
| | a2 | minutes (Penalty assessed per | seconds |
| | | uncompleted zone) | per zone |
| | | -Lane departure as determined by judge | Reposition, |
| | b1 | -Two wheels completely crossing the lane | +10 |
| | | line. (Otherwise, lane infringement) | seconds |
| | | -Vehicle stops on the track and is unable to proceed for 5 seconds or more | Reposition, |
| Track Driving | b2 | | +20 |
| | | | seconds |
| | b3 | -Lane infringement | +5 seconds |
| | b4 | -Failure to return to the correct lane | Reposition, |
| | | | +10 |
| | | within 5 seconds after a lane departure | seconds |
| Unable to Proceed | с1 | -Unable to proceed after being | +30 |
| | | repositioned. (Maximum 30-second wait | seconds |
| | | before this penalty is applied) | per zone |

- Abandonment is not permitted. If the 4-minute time limit is exceeded or the vehicle is unable to proceed, penalties corresponding to the uncompleted zones will be applied. In the case of a 'Unable to Proceed,' penalties for both the uncompleted zones and 'Unable to Proceed' itself will be assessd.
- Lane Infringement: One of the vehicle's wheels touches a lane line (solid or dashed). (In the case of a continuous infringement, it will be counted as a new violation for every two (2) seconds)
- Lane Departure: Two wheels completely crossing the lane line.
- Restart: A procedure initiated when the vehicle fails to start correctly, loses control, or starts unexpectedly. During a restart, teams are permitted to power the vehicle off and on or reset the program.
- Reposition: A procedure initiated when the vehicle deviates from its lane and cannot

return to the correct path of travel on its own. During a reposition, teams are permitted to power the vehicle off and on or reset the program. The exact repositioning spot is chosen by the team leader, but it must be within the same lane and behind the point where the violation was judged to have occurred.

5.2 Mission Race Penalty

| 분 | 분류 코드 내용 | | 페널티 | |
|-----------------|------------------------------|---|--|------------------------|
| | Start d1 | d1 | -Failure to start within 10 seconds of the start signal. (One restart attempt is permitted within the first minute). | Restart |
| Com h | d2 | -Failure to complete the mission within the specified time. | Mission termination | |
| Un le Pre | Unab le to Proc eed | e1 | -Unable to proceed after being repositioned (Mission points accrued up to this point will be recognized) | Mission termination |

| 분류 | 코드 | 내용 | 페널티 |
|----|----|----|-----|
|----|----|----|-----|

| 분류 | 코드 | 내용 | 페널티 |
|-----------------------|----|---|--------------------------------------|
| Parking | f1 | -Not attempt/Abandon the mission | -200 points |
| | f2 | -Failure to start within 10 seconds of the start signal (One restart is permitted within the first minute) | Restart, -50 points |
| | f3 | -Collision with other parked vehicles. | -20 points per collision |
| | f4 | -Lane infringement during or after parking (If both left/right wheels or both front/rear wheels infringe simultaneously, it is counted as a single violation) | -5 points |
| | f5 | -Failure to park completely within the parking lines (The frontmost part of the vehicle must be inside the parking line. If wheels are on the rear-side lines, parking is considered complete, but a lane infringement penalty will be applied) | Incomplete pakring, -30 points |
| | f6 | -Failure to exit the parking space between 2 and 10 seconds after a successful park. | Incomplete pakring, -30 points |
| | f7 | -Failure to reach the destination ('OUT') line. | -40 points |
| Obstacle Avoidance | g1 | -Not attempt/Abandon the mission | -200 points |
| | g2 | -Failure to start within 10 seconds of the start signal (One restart is permitted within the first minute) | Restart, -50 points |
| | g3 | -Collision with Obstacle Vehicle #1 | Reposition, -20 points per collision |
| | g4 | -Collision with Obstacle Vehicle #2 or #3 | Reposition, -60 points per collision |
| | g5 | -Infringement of a solid lane line | Reposition, -10 points |

| 분류 | 코드 | 내용 | 페널티 |
|---------------------------------|----|---|---------------------------|
| | h1 | -Not attempt/Abandon the mission | -100 points |
| | h2 | -When attempting the Crosswalk mission separately, failure to start within 10 seconds of the start signal. | Restart, -50 points |
| | h3 | -Failure to stop before the stop line or in the correct designated position. | -50 points |
| Crosswalk (Traffic Light) | h4 | -Starting while the light is redFailure to start within 5 seconds after the light turns green. | -50 points |
| | h5 | -Infringement of a lane line (dashed or solid). | -10 points |
| | h6 | -Attempting the Crosswalk mission separately (base deduction). -Receiving a reposition judgment due to lane departure. -Collision with the traffic light structure. | Reposition, -30 points |
| | h7 | -Failure of the frontmost part of the vehicle (including sensors) to cross the line after the crosswalk within the given time. | -20 points |

5.3 Mission Success Determination

- Parking: At least one front wheel crosses the destination ('OUT') line after the maneuver is completed
- Obstacle Avoidance: The front of the vehicle (including sensors) crosses the line through an obstacle after the maneuver is completed
- Crosswalk (Traffic Light): The front of the vehicle (including sensors) crosses the line behind the crosswalk after the maneuver is completed

5.4 Other

- Starting Position for the Crosswalk (Traffic Light) Mission: The start is located behind the finish line of the Obstacle Avoidance zone.
- Teams that have completed the Time Trial race are permitted a 15-minute to download the program for the Mission races.