Q1

Explain how the bot should traverse the arena while ensuring following factors:

* The successful collection of all materials from the specified manufacturing locations and their deposition at the designated deposition zones.
* Compliance with the black path boundary rule and proper handling of ramp and obstacles.
* Minimum time for task completion

To successfully traverse the arena and complete the task efficiently, the bot should follow these steps:  
  
Q2

What are the limitations for designing an optimal two-wheeled, self-balancing bot that can perform the following tasks:

* Traverse the track efficiently while maintaining balance, even over ramp obstacles.
* Pick and place foam cubes (5x5x5 cm) from CPs to deposition zones, ensuring the manipulator operates effectively without exceeding the bot’s size constraints.

Q3

During a theme run, your bot encounters multiple challenges while completing the task. The bot strays outside the black path boundary twice (Path Penalty), requires repositioning three times, deposits one block incorrectly, and touches the ground (arena) once. The bot successfully completes the run in 8 minutes but triggers the 1-second buzzer beep at the end of the run.

* a) Identify all the penalties incurred during the run and calculate the total number of penalties.
* b) Explain the steps you would take to minimize such penalties in the next run, considering both hardware and software aspects.
* c) If the second run does not allow software modifications but permits hardware changes, suggest specific hardware improvements to reduce penalties like Ground Penalty and Block Penalty.

Q4

Based on the configuration table and arena setup, your bot must pick blocks from M1 (B4, B6, B7) and M2 (B1, B5, B12) and deposit them in D1, D3, and D6. The arena includes obstacles at O1 and O3, a ramp at R2, and has checkpoints every 30 cm.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Start** | **Deposition Zone (D)** | **Manufacturing Zone (M)** | **Obstacle** | **Ramp Obstacle** |
| S2 | D1 | B4, B6 | O1, O3 | R2 |
|  | D2 | - |  |  |
|  | D3 | B1, B12 |  |  |
|  | D4 | - |  |  |
|  | D5 | - |  |  |
|  | D6 | B5, B7 |  |  |

* a) Propose an optimal path for the bot to minimize the total traversal time while ensuring it follows all rules (e.g., checkpoint crossing, block pickup order, etc.).
* b) Calculate the minimum number of times the bot would need to cross obstacles and checkpoints based on your proposed path.
* c) Justify your choice of path by discussing its impact on minimizing penalties and maintaining balance.

Q5  
During a theme run, the bot strays off the path multiple times, requiring manual interventions (MIs) for repositioning. According to the rules:

1. Explain the process of repositioning the bot after it strays off the path.
2. What are the implications of exceeding the maximum allowed number of repositioning events during a single run?
3. How does the bot's orientation and checkpoint compliance affect the repositioning process?

Q6 Identify and discuss potential issue /issues that could arise in Bluetooth communication during the run (e.g., interference or range limitations). Propose solutions to mitigate these issues.

Q7

During the theme run, the bot has a maximum of 10 minutes (600 seconds) to complete the task. However, various penalties and conditions could affect the total run time. Consider the following events during a single theme run:

* The bot strays off the path, requiring 2 repositions.
* The bot enters the manufacturing zone and incurs a Path Penalty (PP).
* The bot accidentally drops a block outside the designated Deposition Zone, resulting in a Block Penalty (BP).
* The bot takes 1 minute (60 seconds) to complete each pick and place operation, and there are 3 blocks to be placed.
* The bot reaches the second "S" and triggers the buzzer beep at the 580-second mark.

Based on this, calculate the total run time, accounting for the penalties and repositions.

Q8

How do Path Penalty (PP) and Destruction Penalty (DP) affect the bot’s score during the theme run?

Q9

If the bot’s wheels cross the boundary of the manufacturing zone (M), how would the team handle the Path Penalty (PP)? Would it affect the bot’s overall score of the run, and what strategies would you suggest to avoid this penalty?(**Different Causes of this penalty**)

Q10

A team completes the theme run in 540 seconds, picks 5 blocks correctly, and deposits 4 blocks correctly. The bot incurs the following penalties:

* 1 Block Penalty (BP)
* 1 Destruction Penalty (DP)
* 1 Ground Penalty (GP)
* 3 Manual Interventions (MI)

Additionally, the bot crosses 3 obstacles (OB) and 2 ramps (RB). Calculate the total score for this run.