UNIVERSITY OF MORATUWA
Faculty of Engineering
Department of Electronic and Telecommunication Engineering
B. Sc. Engineering
Semester 3 Examination

EN2532 ROBOT DESIGN AND COMPETITION

Time Allowed: *Two (2)* hours September 2021

ADDITIONAL MATERIAL:

- No additional material is provided.

INSTRUCTIONS TO CANDIDATES:

- This paper contains 2 questions on 2 pages (page 2 to page 3).
- Answer **ALL** questions.
- This examination accounts for 40% of the module assessment. The total maximum mark attainable is 100.
- This is partially-open book examination. You are allowed to keep 2 handwritten (both sides) A4 sheets with you.
- Use plain A4/ruled A4/square ruled A4 papers to write your answers.
- Other instructions regarding the examination are provided to you in the Moodle page.

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1. The DARPA Grand Challenge is a prize competition for autonomous vehicles, funded by the Defense Advanced Research Projects Agency, the most prominent research organization of the United States Department of Defense. Such competitions pave the way to revolutionary, high-payoff research that bridges the gap between fundamental discoveries and everyday applications. The initial DARPA Grand Challenge (2004) was created to spur the development of technologies needed to create the first fully autonomous ground vehicles capable of completing a substantial off-road course within a limited time. The most recent DARPA challenges have focused on autonomous emergency-maintenance robots.
   Assume that you have been nominated as the head of the design committee of a Sri Lankan robot competition focusing local university students. The competition should be able to be held in both physical and virtual conditions.

   a. As the first step of designing the robot competition challenge, you are required to identify 6 subtasks a mobile robot should perform. It has been decided that out of the 6 subtasks, you can include 4 subtasks that are commonly tested in contemporary robot competitions, and the remaining 2 subtasks should be novel and with sufficient complexity. Identify the 6 subtasks and explain adequately the robot design skill you need to test with the proposed subtasks.
   [20 marks]

   b. Explain how you would solve the 2 novel subtasks mentioned in 1(a). You are required to discuss the solution to each novel subtask using technical aspects learned during EN2532 with sufficient robustness for different competition settings (e.g. lighting, arena surface etc.).
   [15 marks]

   c. Sketch the proposed final arena using a full A4 sheet (3D isometric or 2D top view are accepted). Marks will be allocated based on the completeness, required complexity, and progression (from easier subtask at the beginning to harder subtask at the end) of the arena for a university competition. Use additional sheets to illustrate certain areas of the arena, when needed. Mention all the required dimensions (lengths, heights, angles etc.), and make sure the values are reasonable. [25 marks]

[A total of 60 marks for Question 1]

2. A computer simulation is an application designed to imitate real-life situations. Due to the global COVID pandemic, EN2532 final robot competition had to be held as a Webots virtual simulation instead of a physical competition.
   a. Explain the advantages and disadvantages of using a simulator for a given engineering design task. [5 marks]
   b. A computer simulation should adequately mimic all the conditions of a physical implementation, or else the meaning of simulation is lost. Explain how you achieved a near equal representation of your physical robot in the simulator. What aspects did you fail to take into consideration when developing the virtual robot, if any? [5 marks]
   c. Describe your group's approach for EN2532 final virtual robot competition. You are required to explain sufficient details on how each subtask was addressed, and design decisions of your robot regarding the mechanical design, sensors, actuators, controller, and power. [10 marks]
   d. If your robot didn't work according to your expectation in the final virtual competition, explain what went wrong. If it successfully completed the task, what improvements can you make to increase its robustness and timing? [8 marks]
   e. If you are given another chance to resubmit your virtual robot code, what changes will you make to win the competition? [12 marks]

[A total of 40 marks for Question 2]