Student Name: _____ Student ID # _____

Question 1: Robotics and Ethics. 20 points.

While some people are concerned about robots taking jobs away from people, Karen doesn't think robots are any different than any other technology—they make some jobs easier and some obsolete but there are always other things people can do. Without technology, she claims, we'd be struggling to get by using just our bare hands—all of our time and effort would be spent in gathering food and avoiding predators. It is only because we have technology that some people are able to become doctors, scientists, philosophers, artists, and so on, and technology helps to create leisure time for everyone. Technology, her argument says, is what allows us to live longer, more fulfilled lives, and robots are just another part of that technology.

Do you agree with all, some, or none of Karen's positions? **Explain your answer.**

Question 2: Schema Theory. 10 points.

How does the use of perceptual and motor schemas promote modularity and code reuse, as compared to the ad hoc behaviors given by Brook's for his subsumption architecture? **Explain your answer.**

Question 3: Robot "Architectures." 10 points.

We want to create a robot tour guide for a national park. The robot should move from one (predefined) point of interest to the next while avoiding bumping into obstacles, inviting tourists that it detects to follow it on its route. When it arrives at a point of interest, if there are any tourists present, it should ask them if they want to know about the things found at that site. If they say yes, it should talk about and points at the various items of interest there.

Which would be a better *architecture* choice for this system, the subsumption architecture or a potential fields architecture? **Explain your answer.**

Question 4: Potential Fields. 20 points.

Rahul has created a robot for moving about within buildings, delivering mail to individual offices. He has chosen to use potential fields for navigation purposes.

a. Rahul becomes concerned, however, when he realizes that his robot cannot sense entire obstacles at once—it can only sense the side(s) facing the robot. He worries that his robot, therefore, won't be able to calculate the potential field behind obstacles as shown in Figure 1. Are his worries well founded? **Explain your answer.**

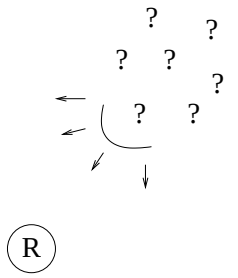

Figure 1: A robot (R) with a partially sensed obstacle and a potential field calculated in front of it but not behind it.

b. Rahul has reached the point of testing his system and finds that by combining the `move-to-goal` and `avoid-obstacle` behaviors using potential fields, his robot can get around in most of the test area, but that the robot fails to move through doorways. What happens is that, when the robot gets close to the doorway, the potential fields from the door frame sum with the potential field from the goal to produce a zero value as shown in Figure 2(a). If the potential fields are defined as shown in Figure 2(b), how could he have his robot dynamically adjust them in order to get through doorways safely?

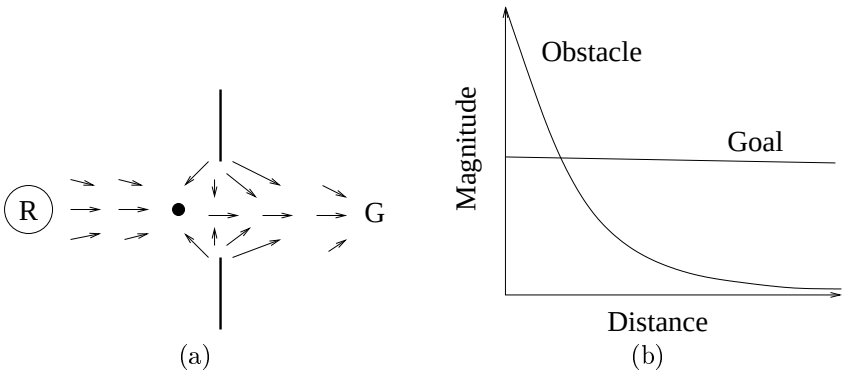

Figure 2: Potential fields and doorway navigation. (a) Potential fields between robot (R) and Goal (G), showing summation to zero at black dot. (b) Potential field functions.

Question 5: Implementing the Reactive Paradigm. 10 points.

On page 184 of the text, the author introduces the idea of *exceptions* and suggests that if a robot competing in the Pick-Up-The-Trash Contest is trying to pick up soda cans and doesn't succeed in picking one up in 10 minutes that it might switch from a random wander behavior to a "raster scan" movement behavior or might adjust the color values for the soda can object for which it is searching. How does this idea of exception handling conflict with the way the author says a purely reactive robotic system should act? **Explain your answer.**

Question 6: Sensing. 20 points.

Sensors of different types have different characteristics such as sensitivity, accuracy, and so on.

a. Does this make applying sensor fusion to two sensors of different types easier, more difficult, or no different than applying sensor fusion to two sensors of different types? **Explain your answer.**

b. Does using sensor fission to assign each different type of sensor to a different behavior overcome any difficulties there may be in using sensor fusion with sensors of different types? **Explain your answer.**