Student Name: ______________________ Student ID # ______________________

Question 1: The Cartographer of Jeeves. 20 points.

A. If you were given the task of creating a cartographer for the “Clean up the tennis court” AAAI Robot Competition, would you choose to have it use a metric map, a topological map, both, or neither? **Explain your answer.**

B. Did Jeeves, in fact, use a metric map, a topological map, both, or neither? **Explain your answer.**

Question 2: The Cartographer of Xavier. 20 points.

A. If you were given the task of creating a cartographer for office delivery, would you choose to have it use a metric map, a topological map, both, or neither? **Explain your answer.**

B. Did Xavier, in fact, use a metric map, a topological map, both, or neither? **Explain your answer.**

Question 3: Topological Path Planning. 10 points.

Does it ever make sense to search for the "best path" through a map that contains no distance information?

Question 4: Metric Path Planning. 15 points.

Can you use a wavefront-based planner with a quadtree map? **Explain your answer.**

Question 5: Sensor Models. 15 points.

The Murphy textbook gives the following set of equations, which is lists as Equation Set 11.1, to represent the probability that a given sensor reading would occur if a given grid element were *Occupied* or *Empty*:

$$\begin{aligned} P(Occupied) &= \frac{(\frac{R-r}{R}) + (\frac{\beta-\alpha}{\beta})}{2} \times Max_{occupied} \\ P(Empty) &= 1.0 - P(Occupied) \end{aligned}$$

As we discussed in class, these equations aren't correct, because $P(H)$ is used to refer to an *unconditional* probability, as discussed on page 831 of the text. However, these equations are meant to stand for *conditional* probabilities. These would be denoted as:

$$\begin{aligned} P(s = r|Occupied) &= \frac{(\frac{R-r}{R}) + (\frac{\beta-\alpha}{\beta})}{2} \times Max_{occupied} \\ P(s = r|Empty) &= 1.0 - P(s = r|Occupied) \end{aligned}$$

As we discussed in class, these equations *still* aren't correct, because $P(s = r|Empty)$ does not necessarily equal $1.0 - P(s = r|Occupied)$. Consider Example 2 from Chapter 11, depicted in Figure 11.5 on page 384. Now, assume that the *other* grid element at $r = 6, \alpha = 5$ (that is, the one across the acoustic axis in the diagram from the one shown in black) is occupied but that no other grid elements are occupied.

A. What is the probability that the sensor will give a reading of $s = 6$ based on our equation for $P(s = r|Occupied)$ calculated using that grid element? **Explain your answer.**

B. What is the probability that the sensor will give a reading of $s = 6$ based on our equation for $P(s = r|Empty)$ calculated for the grid element shown in black in Figure 11.5? **Explain your answer.**

C. Are these probabilities consistent with one another? **Explain your answer.**

Question 6: Sensor Models and Sensors. 20 points.

A. Would you run into the kinds of problem covered in Question 3 if you were using a sensor that sent out a narrow beam (such as a laser), rather than a cone (as you have with the sonar), for elements in Region I? **Explain your answer.**

B. Would you run into the kinds of problem covered in Question 3 if you were using a sensor that sent out a narrow beam (such as a laser), rather than a cone (as you have with the sonar), for elements in Region II? **Explain your answer.**