Robotics II Final, Spring 2011.

T/F   4 points each

1. In all friction form closure grasps, every contact point can at least one other contact point in its friction cone.

2. Unit quaternions have 4 elements, but only three degrees of freedom.

3. Some LCPs arising in the Stewart-Trinkle time stepping method have non unique solutions.

4. A* search with cost-to-come = 0 is equivalent to Best-First search

5. Sample-based methods are preferred in motion planning, because the number of samples needed for a given resolution is independent of the dimension
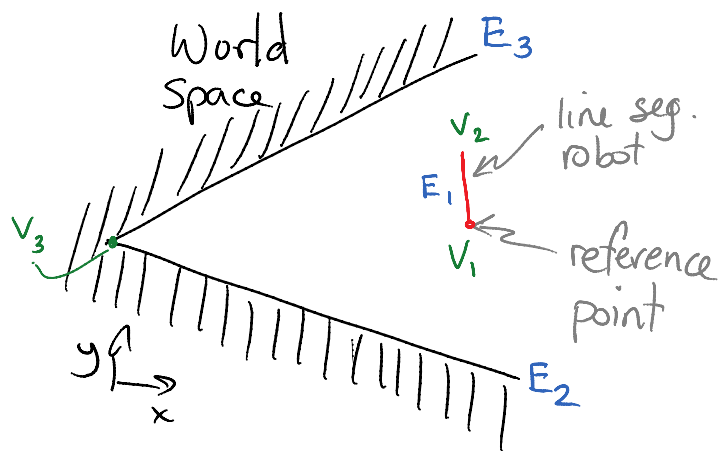
of C-space.

6. A robot with 7 joints and a position-controlled parallel-jaw gripper has an 8-dimensional C-space.

Short Answer Questions

World Space

E_3

V_2 — line seg. robot

E_1

V_3

V_1 — reference point

$y \uparrow$, x

E_2

1. Sketch the curves in the workspace when the radio plots change qualitatively (these are known as critical curves). Label the curves (E_1, V_1), etc

2. Describe how a randomized potential field method works and how it escapes local minima. Under what circumstances does it fail?

3. Let C be the "disk" shown on the right. Without the identifications shown, C has 4 components. How many components exist with the identifications shown?
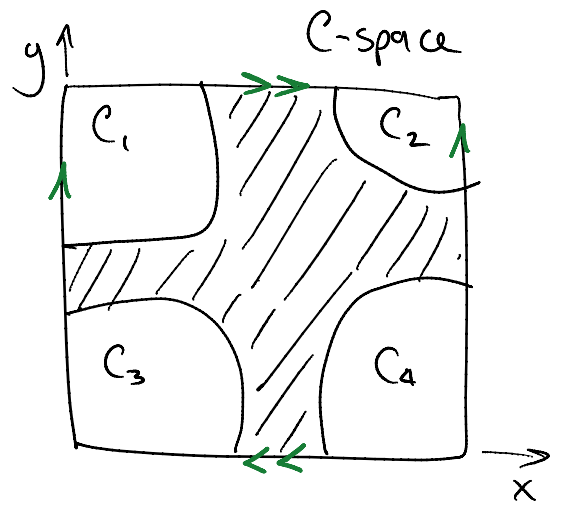
C-space
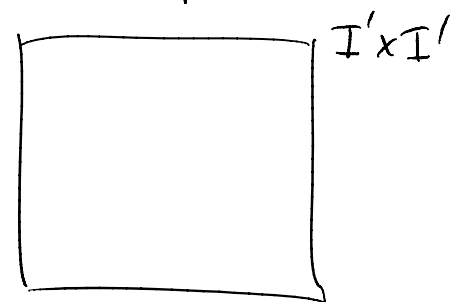
4. For the C-space shown on the right, extend the idea of a visibility graph to curved objects.
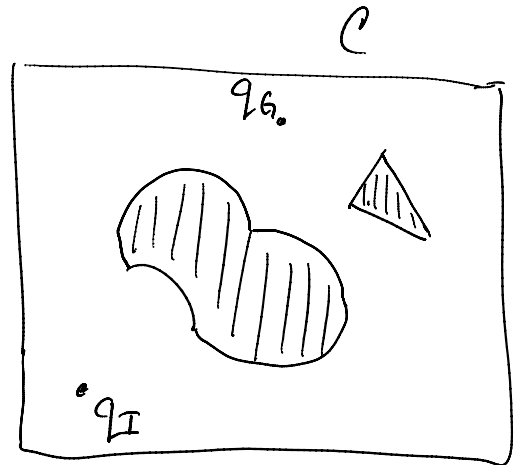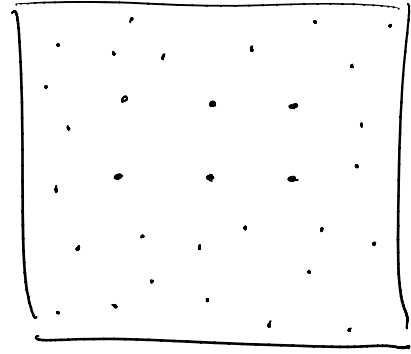
Draw the graph for the obstacles and q_I and q_G.

C

5. Give pseudo-code defining a van der Corput sequence on a disc in $\mathbb{R}^2$.

$I' \times I'$

6. Find the points of maximum dispersion in the region shown

dispersion in the region shown
on the right.

Compare results for two
metrics: L_1 and L_∞

7. Describe the main differences between sampling-based
and combinatorial motion planning methods.

Analysis Questions (10 points each)

1. Let X be a vector space and let x & x' be points in X.
   Prove that $\rho(x, x') = abs(x - x')$ <u>is</u> or <u>is not</u> a metric.
   Note that abs = absolute value, which applies to each
   element of a vector.

2. Define the most impressive analysis problem you
   prepared for, but I didn't ask. Then solve it.