COMP417, Winter 2017
Quiz on potential fields and LQR
First Name:
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Student #:

1) [0.5 pts] You are given a 2D environment with two circular obstacles of radius 1. One obstacle is located at (x0, y0) and the other at (x1, y1). You are also given a destination (xd,yd). Write a potential function, consisting of an attractive term and two repulsive terms, and the associated force that makes a point, omnidirectional robot reach the destination from any point in the 2D environment. Do not forget to normalize your force vector.

2) [0.5 pts] You are given an omnidirectional robot that moves on a surface with friction. The continuous dynamics of the robot are given by the following equation, which extends the double integrator dynamics:

$$m\ddot{\mathbf{p}} = \mathbf{u} - \alpha\dot{\mathbf{p}}$$

where the 2D vector p denotes the position of the robot, the 2D vector u denotes the controls, m is mass, and alpha is the coefficient of friction. Formulate this control problem as an LQR problem. Specifically, define the state x, discretize the system and derive linear dynamics

$$\mathbf{x}_{t+1} = A\mathbf{x}_t + B\mathbf{u}_t$$

as well as a cost function

$$g(\mathbf{x}_t, \mathbf{u}_t) = \mathbf{x}_t^T Q \mathbf{x}_t + \mathbf{u}_t^T R \mathbf{u}_t$$

that will stabilize the point robot around the zero state and zero control. Write down your choice of matrices A, B, Q, R. Hint: use the fact that $\dot{\mathbf{p}} = \mathbf{v}$ to make the system linear.