EL5223 Homework

1. Consider the two degree-of-freedom robotic manipulator shown below. This robotic manip-
ulator is prismatic-revolute (PR), i.e., has two joints, the first one being prismatic and the
second one being revolute. The prismatic joint can be used to assign the distance d_1 and the
revolute joint can be used to assign the angle θ_2. Hence, the joint variables for this robotic
manipulator are d_1 and θ_2. The end-effector position shown as the blue circle in the picture
below has two-dimensional Cartesian coordinates (x, y). The distance D between the axis of
rotation of the revolute joint and the end-effector location is a constant.

   (a) Find the forward kinematics for this robotic manipulator, i.e., given the joint variables
   (d_1, θ_2), find the end-effector position (x, y).

   (b) Find the inverse kinematics for this robotic manipulator, i.e., given the end-effector
   position (x, y), find the joint variables (d_1, θ_2).

   (c) Find the velocity kinematics for this robotic manipulator, i.e., find the relation between
   the joint variable rates $\begin{bmatrix} \dot{d}_1 \\ \dot{\theta}_2 \end{bmatrix}$ and the end-effector velocity $\begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix}$.