Nanotechnology to Robotics

Instructor: Phillip Wu

Problem Set 1 Fundamental Concepts

Due week 2 February 26 2024

1. Find the sum of the two vectors, $r\_{1}=3\hat{x}+4\hat{y}$ and $r\_{2}=1\hat{x}+5\hat{y}$. Find the total length from $r\_{1} to r\_{2}$.

2. Suppose a rotational transformation is defined as $R\_{z}(θ)=\left[\begin{matrix}\begin{matrix}cosθ&-sinθ\\sinθ&cosθ\end{matrix}&\begin{matrix}0&0\\0&0\end{matrix}\\\begin{matrix}0&0\\0&0\end{matrix}&\begin{matrix}1&0\\0&1\end{matrix}\end{matrix}\right]$. If this acts on a vector $P\_{1}=\left[\begin{matrix}0.0\\2.0\\0.0\end{matrix}\right]$, calculate $R\_{z}\left(30\right)P\_{1}$.

3. Consider a simple pendulum consisting of a massive bob suspended from a fixed point by a string. Let T denote the time (period of the pendulum) that it takes the bob to complete one cycle of oscillation. How does the period of the simple pendulum depend on the quantities that define the pendulum and the quantities that determine the motion? Let’s look into the simple planar pendulum Matlab example. Open the Matlab example file, pendulum.slx. Open the Simulink file by double click. Go to the Library Browser and add a scope to the simulation to view the x and y output. Complete this task and then press run to do a simulation. Then look at the Workspace to view the out SimulationOutput. Generate a plot of the time compared to the x position and force.

4. A square loop of wire with sides of length 20.0 cm and carrying a current of 10.0 A is placed inside a magnetic field with magnitude 5.0 T. What is the maximum magnitude of torque on the loop?

5. Consider the following differential equations, $\frac{d^{2}x}{dt^{2}}=0;\frac{d^{2}y}{dt^{2}}=-g, g=9.8m/s^{2}$. Find the analytical solution to the differential equations.