

11th Homework

- In this homework, we shall model and simulate a 3D mechanical system with proper animation.

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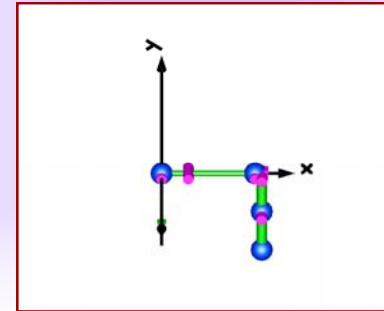
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Multi-body System

- We wish to model and simulate the following multi-body system using the 3D mechanics sub-library of the multi-bond graph library:



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Multi-body System II

- Although this is actually a 2D mechanical system, we shall use the 3D mechanical library, as this enables us to hang the two rods of the double pendulum a little in front to prevent these bodies from intersecting with each other graphically.
- There is a revolute joint at the origin. Connected with the revolute joint is a mass of **2 kg** with an inertial tensor, represented by a diagonal matrix with diagonal elements of **$0.3 \text{ kg}\cdot\text{m}^2$** .
- The mass is accelerated by an external torque of **$2 \text{ N}\cdot\text{m}$** . The torque must be applied in the same direction as the rotational axis of the revolute joint.
- Also connected to the revolute joint is a rod of **0.1 m** length that rotates around the origin.

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Multi-body System III


- At the other end of the rod, there is a second revolute joint, connected to a second rod of 0.25 m length.
- There follows a third revolute joint that connects to a prismatic joint and back to a wall that is located 0.4 m to the right of the origin.
- Due to the two walls, there exists a planar kinematic loop. As explained in class, one of the three revolute joints will have to be replaced by a cut joint in order to break that loop.
- In parallel with the prismatic joint, there is a damper with a damping coefficient of $50 \text{ N}\cdot\text{s}/\text{m}$.
- Also connected to the moving end of the prismatic joint, there is a second mass of 1 kg with an inertial tensor, represented by a diagonal matrix with diagonal elements of $0.03 \text{ kg}\cdot\text{m}^2$.

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Mathematical Modeling of Physical Systems


Multi-body System IV


- We have so far built a model of a compressor driven by a mechanical motor.
- Let us simulate this system over a duration of **10 sec** and watch the animation.

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Multi-body System V


- To make the system a bit more interesting, we shall now hang a double pendulum off the moving part of the prismatic joint.
- The top end of the first pendulum rod is located at the center of the prismatic joint in its initial position, yet **0.02 m** in front, so that the pendulum does not bump into the piston.
- The first rod is **0.15 m** long.
- At the end of that rod, there is a third mass identical to the second mass.
- A rod of **0.02 m** length connects that mass to the top end of the second pendulum rod. The purpose of that short rod is to hang the second pendulum **0.02 m** in front of the first pendulum to prevent that they bump into each other.

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Mathematical Modeling of Physical Systems


Multi-body System VI


- The second pendulum is connected to the first pendulum by another revolute joint.
- The second pendulum is equal in size to the first.
- There is a fourth mass of identical size as the third connected to the end of the second pendulum.

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Multi-body System VII

- Simulate the enhanced multi-body system over a duration of **10 sec** and watch the animation.

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