PROJECT 2

November 25, 2014

Turning in your assignment: place all your files in a directory called "lastName_Project_2", zip that directory, and upload the resulting file "lastName_Project_2.zip" in the appropriate Dropbox Folder at Learn@UW.

For this project you will have to use your simEngine2D code to determine the time evolution of the slider-crank mechanism in section 8.2 of the textbook (pp. 283). Specifically, you'll work with the mechanism in Fig. 8.2.3. The dynamics analysis setup is described in subsection 8.2.4. Please note that the gravity acts as indicated in the problem (positive x direction).

1. Generate two files, slidercrank.acf and slidercrank.adm that you use in modeling the mechanism and setting up the dynamics analysis. For this simulation, $t_{end} = 1$ and the step-size $\Delta t = 0.001$ (all units SI). Choose an appropriate number of output steps.

2. Run the required analyses to generate the plots 8.2.5 through 8.2.8 (pp. 288).

The output of simEngine2D should be an ASCII file called slidercrank.res, which stores position, velocity, acceleration, and Lagrange multiplier values at each time step. This file should have as many lines as output times you decided to use and each line should contain (in this order): 1 value for t, 9 values for $\mathbf{q}$, 9 values for $\dot{\mathbf{q}}$, 9 values for $\ddot{\mathbf{q}}$, and 8 values for λ, for a total of 36 values per line.

The zip file that you turn in should include:

1. **All** the MATLAB files necessary to run your simEngine2D. Make sure that there is a file called simEngine2D.m which can be called from the MATLAB command line and generates the slidercrank.res output file. This directory should also include the files slidercrank.acf and slidercrank.adm that you used to generate slidercrank.res.

2. Plots (in png format), which are supposed to look like plots 8.2.5 through 8.2.8 in the textbook.

Keep all your files in a directory lastNameProject2. It is this directory that you should zip to create the file lastName_Project_2.zip that you submit. The grader will unzip the file, start MATLAB from within the directory lastNameProject2, and type:

```
>> simEngine2D('slidercrank')
```

at the MATLAB prompt. He will not debug your code if this fails to generate the results file slidercrank.res.

Hints:

- You may constrain the motion of body 3 using an *AbsoluteAngle* constraint with $\phi_3 = 0$ and an *AbsoluteY* constraint with $y_3 = 0$.
- For this problem, the concentrated point-force F_c has a rather complicated expression that depends both on the position and velocity states of the body it acts on.

As such, the `PointForce` force element we have been using so far is not appropriate since it can only deal with concentrated forces whose x and y components are simple functions of time (as defined through the `funX` and `funY` properties of a `PointForce`).

To accommodate the concentrated force required by this model, you will have to use a separate Matlab routine. To do this, expand the ADM modeling language by introducing a new type of force element, namely `PointForceFile`. The JSON description of this force element will be of the following form:

```
{
  "name": "point_force_file",
  "id": 1,
  "type": "PointForceFile",
  "body1": 3,
  "sP1": [1.4, 0.2],
  "frame": "GRF",
  "mfunction": "my_force"
}
```

Such a force element will assume that a file `my_force.m` exists in the current directory and that it defines a Matlab function with the following signature:

```
F = my_force(t, q, qd)
```

This function should then calculate and return the 2-dimensional force $\mathbf{F} = \mathbf{F}(t, \mathbf{q}_i, \dot{\mathbf{q}}_i)$ acting on body i ($i = 3$ in the JSON snippet above), where t is the time, $\mathbf{q}_i$ are the generalized coordinates for body i at time t, and $\dot{\mathbf{q}}_i$ are the generalized velocities for body i at time t.