ME751: Assignment 5

Problem 1. Going back to slide 8 of the 10/07/2016 lecture, derive the expression of $\hat{\gamma}$ for the four basic constraints when using the **r-p** formulation.

Problem 2. Implement two (possibly more, if you choose to) MATLAB functions that provide all the computational kinematics quantities that are associated with the basic GCons Φ^{DP1} and Φ^{CD}. Stick with the **r-p** formulation. Specifically, your MATLAB code should be able to return any or all of the following quantities: the value of the expression of the constraint, the right-hand side of the velocity equation ν, the right-hand side of the acceleration equation γ, and the expression of the partial derivatives $\Phi_{\mathbf{r}}$ and $\Phi_{\mathbf{p}}$. Since you don't need all these quantities all the time, you should devise a methodology (using maybe flags) to instruct the subroutine what quantities are actually needed.

Observation 1: There are two ways to go about specifying the attributes of your GCon; i.e., who i is, who j is, where point P is, etc.:

a) Nice but hard: use an input file that contains information about the *attributes* of your model's GCons. You will also have to think about the format in which you expect the user to provide the required attributes. In conclusion, think about how you want the model attributes to be provided to you, and then generate a file with extension "`me751.mdl`" (from model), that actually stores the attributes. As an example, take a look at the ADAMS adm file that is uploaded on the class website. If you want to push it to an extreme, you can actually start using adm files as your model definition files. To put things in perspective, this mdl file is the input file, what the `simEngine3D` code picks up to generate the actual GCons that you have in your model.
b) Easier: hardcode in MATLAB the attributes of the GCons you have in your mechanism. For each mechanism you will have to have a MATLAB file that sets up the model.

Observation 2: You will have to have another MATLAB file called "`simEngine3D.m`", which when executed is expected to generate all the Kinematics quantities listed above by reading the attributes and data specified in a "`me751.mdl`" file that you also have to generate. You won't have an input file if you go with solution b) above.

Observation 3: Keep in mind that body j can be the ground. In this case, $j = 0$. This is relevant since the number of columns in the Jacobian is half – there are no partial derivatives with respect to $\mathbf{r}_j$ or $\mathbf{p}$. You will have to be able to properly dimension the size of the vectors/matrices that you work with to account for the fact that one of the bodies in the GCon is ground and as such it does not bring generalized coordinates along.

Observation 4: Please work in GitHub (share your repo link). If you want to see how the 2010 students went about this, take a look here: http://sbel.wisc.edu/Courses/ME751/2010/SimulationEngine/.

Problem 3 [Bonus]. Derive the EOM when using the Euler Angles to characterize the orientation of a rigid body. That is, take care of the **r-ϵ** formulation. Your derivation can be guided by the discussion and slides on the topic, see 10/07/2016 slides & video.