MCE/EEC 647/747
Homework 6 - Spring 2017
Due 5/4/17

1: Consider the RPR robot used for HW3 and HW5. Set all physical parameters to one (masses, lengths and moments of inertia). Select one control approach from below and adjust the gains to obtain asymptotic tracking of sinewave reference trajectories for each link (all with frequency 1 rad/s, amplitudes 1 rad, 1 m and 1 rad and the same phase).

1. **Adaptive Inverse Dynamics**: Use an initial condition for the parameter estimate integrator equal to 50% of each true parameter value. Tune system gains to see accurate tracking and steady parameter convergence or small oscillation around a fixed mean.
2. **Robust Passivity-Based Control:** Find the Y_{av} regressor and verify it. As done in class, introduce a random perturbation of the plant basic parameters, find the corresponding perturbed Θ parameters and use them in the simulation. The controller should use nominal parameters. Introduce a perturbation level of 50%. Tune system gains to see accurate tracking with small chattering.
3. **Adaptive Passivity-Based Control:** Same as for adaptive inverse dynamics. (you must also find the Y_{av} regressor and verify it).

Choose one between 2 and 3:

2: Design and tune a high-gain observer to generate state estimates for the robot of Problem 1. First verify the accuracy of the estimates by simulating the observer alongside your chosen controller, but without using the estimates for feedback. Once this works, use the estimates for feedback and re-tune the system if necessary for good performance

3: For the robot of Problem 1, modify the model to include an external force acting on point P (use $l = 0.2$). The force has world direction $[1\ 1\ 1]^T$ and a magnitude given by $\sin(2t)$ for $t \geq 10$. Before $t = 10$, the force is zero. Design and simulate a joint space impedance controller based on inverse dynamics and simulate as indicated below:

1. Use "low" impedance settings so that trajectory deviations are significant, but joint torques are small.
2. Use "high" impedance settings so that trajectory deviations are small, at the expense of large joint torques.