MCE/EEC 647/747
Final Project- Spring 2019
Due 5/10/19

1: Model Updates
Please incorporate the following updates in your work:

- The value of kinematic parameter d should be 0.55 m. Also, the distance to the end plate from o3 should be 0.35 m (not 0.91 m).
- A more accurate friction model is obtained by including Coulomb friction in joints 2 and 4 in addition to joint 1 and viscous friction in all 3 joints. Extend the regressor and the parameter vector as indicated in the attached m-file. Optimal parameters are loaded with this file.
- Instead of `sign(x)` use `tanh(2*x)`. This is done to prevent issues with numerical solvers in Simulink. Make this change in the plant model (state derivative function) and in the control regressor.

1: Robust Passivity-Based Tracking Control of the WAM Model
The objective is to implement and tune an RPBC tracking controller for joints 1,2 and 4 of the WAM robot by simulation, with joint 3 fixed at zero. Procedure:

1. Continue the work assigned in HW6 with the above updates. Tune the controller so that asymptotic tracking is obtained in an off-nominal case (select your own level of uncertainty). The control torques should remain within ± 25 Nm.

2: Optimal Trajectories for Parameter Estimation

- Continue the work assigned in HW6 with the above updates. To improve convergence, scale the cost function as follows: divide the first term by `length(t)` and multiply the second term by the same. With these scalings, the recommended values of λ should result in convergence. If `fmincon` converges to an unfeasible point, repeat the simulation with random initial guesses until constraints are satisfied.
- Show plots of the resulting optimal trajectories and derivatives, to verify the constraints. Report on the achieved value of the elbow and end plate velocities. Report on the outcomes of the optimization (optimal cost, number of iterations, etc.).

3 (optional for extra credit) : Adaptive Passivity-Based Tracking Control of the WAM Model
Implement and tune an APBC tracking controller for joints 1,2 and 4 of the WAM robot by simulation, with joint 3 fixed at zero. Use the same reference trajectories as for the RPBC. Tune the adaptation gain to reduce the torque peaks. Use an initial condition for the parameter estimate vector that matches your perturbed plant parameters in the RPBC.

4: Reporting

- You may work in groups of up to three students. Submit a single report per group. *Attach a signed statement of work distribution.*
- Write a self-contained but concise report that introduces the robot and the control and optimization problems, then focuses on the procedures followed for each part. The report must show all results in the form of tables, charts and images if needed.
- Submit well-commented, running Matlab code correspoding to each task. Include a README file with instructions to reproduce the plots appearing in the report by running the code (figures should be code-generated).
- The report is due on Friday, May 10 by 10 PM via email.