Recommended Assessment

State Space Modeling

Deriving the State Space Representation

1. Using the provided equations of motion $J_r\ddot{\theta} + m_p lr\ddot{\alpha} = \tau - b_r\dot{\theta}$ and $J_p\ddot{\alpha} + m_p lr\ddot{\theta} + m_p gl\alpha = -b_p\alpha$, rearrange and solve to find explicit expressions for the angular accelerations $\ddot{\theta}$ and $\ddot{\alpha}$ in terms of the given parameters.

   Hint: Use MATLAB's symbolic toolbox and solve function to assist with solving the equations simultaneously.

2. Based on the output state $y(t)$ defined in $y(t) = [\theta(t) \quad \alpha(t)]^T$, find the state space matrices C and D in $y(t) = Cx(t) + Du(t)$

3. Using the solution from Question 1 and $x(t) = [\theta(t) \quad \alpha(t) \quad \dot{\theta}(t) \quad \dot{\alpha}(t)]^T$, derive matrices A and B in $\dot{x}(t) = Ax(t) + Bu(t)$.

4. Complete the ***A***, ***B***, ***C***, and ***D*** matrices in the file qs3_rotpen_ABCD_eqns_down.m. The provided file qs3_rotpen_param.m contains all the defined model parameters. Paste the code from the MATLAB script that defines the matrices A, B, C and D.

Model Validation

5. Attach a screenshot of the rotary arm and pendulum scopes. Do the responses match closely? If there are discrepancies between the measured and modeled responses, give a possible reason why the responses don't match.