The Flexible Link experiment consists of a flexible metal ruler (link) with a strain gauge attached mounted on top of the SRV02 load gear shaft and fastened with screws. The strain gauge measures the link tip displacement based on a known stiffness and the torque measured at the gear shaft.

This experiment explores the use of partial-state and full-state feedback to control the movement of the end of the flexible link as a torque is applied to the base of the link. By adjusting the parameters of the compensator design the student can achieve the most rapid system response with the least amount of unwanted oscillation.

State-space model

\[
A = \begin{bmatrix} 0 & 0 & K_{\text{off}}/J_{\text{eq}} & 0 \\ 0 & 0 & -\eta_1 \eta_2 K_1 K_2 + B_2 R_{\alpha} \\ 0 & 0 & (J_{\text{off}} + J_{\text{end}})/J_{\text{eq}} & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ -\eta_1 \eta_2 K_1 K_2/J_{\text{eq}} R_{\alpha} \\ 0 \end{bmatrix}
\]

Free-body diagram

LQR controller design

\[
\dot{x} = Ax + Bu 
\quad J = \int_0^\infty (x^T Q x + u^T R u) dt
\]

Wiring diagram

Simulink block diagram

Applications