Modern Control Systems

Observer Design Notes

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Open loop option:

\[ u(t) \rightarrow \text{plout } A, B, C, D \rightarrow y(t) \]

\[ u(t) \rightarrow B \rightarrow + \rightarrow + \rightarrow \int \rightarrow C \rightarrow \hat{y}(t) \]

\[ \hat{x} \quad \text{estimated} \]

\[ \hat{x} \rightarrow \text{to the controller (estimated state variables)} \]
Closed loop option:

\[ Bu + Ly - LC \hat{x} \]

Notes:
The following are the reasons why we need to use an observer:

- Cost of measuring state variables.
- Unavailability of \( u \).
- Inaccuracy in measuring state variables.
Why we use the observer with closed loop (i.e., $y - \hat{y}$):

1. To compensate for inaccuracies in the values of $A$ and $B$.
2. Lack of the initial value of the error (i.e., $y - Cx$).

We select the poles of the observer to make it 2-10 times faster than the plant, so that the estimate of state variables is available instantly.

\[ T_0 = WN \implies T_0 = s(WN)^{-1} \]

\[ L = T_0 \begin{bmatrix} q_n - q_n \\ q_{n-1} - q_{n-1} \\ \vdots \\ q_1 - q_1 \end{bmatrix} \]