CMPE-242
Applied Feedback Control

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Winter 2016
\[
\int_0^t e^{At} \, dt \beta
\]
\[
e^{At} = I + At + \frac{A^2 t^2}{2!} + \frac{A^3 t^3}{3!}
\]
\[
\phi = e^{At} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} t + \begin{bmatrix} 0 & 1t^2 \\ 0 & 0 \end{bmatrix} \frac{t^3}{3!}
\]
\[ e^{At} = \begin{bmatrix} 1 & 0 \\ t & 1 \end{bmatrix} \]

\[
\int_{0}^{T} e^{At} dt = \int_{0}^{T} \begin{bmatrix} 1 & 0 \\ t & 1 \end{bmatrix} dt = \begin{bmatrix} T & 0 \\ \frac{T^2}{2} & T \end{bmatrix}
\]

**Closed Form Solution:** if \( A \) exists

\[
\int_{0}^{T} e^{At} dt = A^{-1} (e^{AT} - I)
\]
Perd e: Sym. root locus \( \text{rlocus} (-\text{deg}) \).

\[ G = 55(A, B, C, D) \]

\[ [3, p, k] = \text{zpduda}(G) \]

\[ G_{\min} = 38^b (-3, -p, k) \]

\[ \text{rlocus}(G + G_{\min}) \]
\dot{x} = Ax - Bu
\quad y = cx
\quad u \in \mathbb{R}

Q_r - \int_0^T \left[ x^T Q x + u^T R u \right] dt
\quad \text{minimize}

y^T Q y
\quad 2 \text{ into } L_{Qr}

y^T = x^T c^T

Q_r

ct \left[ \frac{1}{y_{\text{min}}} \right]^T
\quad T \times q
\[
\begin{align*}
\dot{x} &= Ax + Bu \\
\dot{y} &= Cx + \delta \\
\dot{\hat{x}} &= A\hat{x} +Bu + L(y - \hat{y}) \\
\hat{y} &= C\hat{x} \\
\hat{x} &= Ax - BK\hat{x} + BKx^c \\
\hat{x} &= A\hat{x} - BK\hat{x} + BKx^c + (C\hat{x} - LC\hat{x}) \\
\hat{x} &= (A - BK - LC)\hat{x} + C\hat{x} + BKx^c
\end{align*}
\]
\[
\begin{bmatrix}
\dot{y} \\
\dot{x}
\end{bmatrix} =
\begin{bmatrix}
C & 0 \\
0 & -k
\end{bmatrix}
\begin{bmatrix}
x \\
\dot{x}
\end{bmatrix} +
\begin{bmatrix}
0 \\
k
\end{bmatrix} u
\]

\[\dot{x} = f(x) - g(x)x^e\]
\dot{x} = Ax + Bu

y = cx
\[ K(s) = -K \begin{bmatrix} sI - (A - BK - LC) \end{bmatrix}^{-1} \]

\[ \begin{align*}
    x &= Ax + Bu \\
    u &= -Kx \\
    y &= Cx \\
    \dot{x} &= Ax + Bu - C(\eta - \hat{\eta}) \\
    \hat{\eta} &= Cx
\end{align*} \]