$$
\mathcal{Q} = \begin{bmatrix} Q & 0 & \cdots & 0 & 0 \\ 0 & Q & \cdots & 0 & 0 \\ \cdots & \cdots & \ddots & \cdots & \cdots \\ 0 & 0 & \cdots & Q & 0 \\ 0 & 0 & \cdots & 0 & S \end{bmatrix}, \quad \mathcal{R} = \begin{bmatrix} R & 0 & \cdots & 0 & 0 \\ 0 & R & \cdots & 0 & 0 \\ \cdots & \cdots & \ddots & \cdots & \cdots \\ 0 & 0 & \cdots & R & 0 \\ 0 & 0 & \cdots & 0 & R \end{bmatrix}
$$

$$
\mathcal{A} = \begin{bmatrix} A \\ A^2 \\ \vdots \\ A^{N-1} \\ A^N \end{bmatrix} \quad \mathcal{B} = \begin{bmatrix} B & 0 & 0 & \cdots & 0 & 0 \\ AB & B & 0 & \cdots & 0 & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ A^{N-2}B & A^{N-3}B & A^{N-4}B & \cdots & B & 0 \\ A^{N-1}B & A^{N-2}B & A^{N-3}B & \cdots & AB & B \end{bmatrix}
$$

$$\bar{J}(x(k), U(k), k) =$$

$$(\mathcal{A}x(k) + \mathcal{B}U(k))' \, \mathcal{Q} \, (\mathcal{A}x(k) + \mathcal{B}U(k)) + U'(k)\mathcal{R}U(k)$$

$$\begin{aligned} = \;& x'(k)\mathcal{A}'\mathcal{Q}\mathcal{A}x(k) + \\ & + 2x'(k)\mathcal{A}'\mathcal{Q}\mathcal{B}U(k) + U'(k)\left(\mathcal{B}'\mathcal{Q}\mathcal{B} + \mathcal{R}\right)U(k) \end{aligned}$$

$$\tfrac{1}{2}U'HU + x_k^T FU + \tfrac{1}{2}x_k^T M x_k$$

$$\min_{x} \frac{1}{2} x^T H x + f^T x \text{ such that } \begin{cases} A \cdot x \leq b, \\ Aeq \cdot x = beq, \\ lb \leq x \leq ub. \end{cases}$$

$$\tfrac{1}{2} U' H U + x_k^T F U$$