$$d(s) = s^n + \alpha_1 s^{n-1} + \alpha_2 s^{n-2} + \cdots + \alpha_{n-1} s + \alpha_n.$$

$$\hat{G}_{\text{sp}}(s) = \frac{1}{d(s)}\left[N_1 s^{n-1} + N_2 s^{n-2} + \cdots + N_{n-1} s + N_n\right],$$

$$A = \begin{bmatrix} -\alpha_1 I_{k\times k} & -\alpha_2 I_{k\times k} & \cdots & -\alpha_{n-1} I_{k\times k} & -\alpha_n I_{k\times k} \\ I_{k\times k} & 0_{k\times k} & \cdots & 0_{k\times k} & 0_{k\times k} \\ 0_{k\times k} & I_{k\times k} & \cdots & 0_{k\times k} & 0_{k\times k} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0_{k\times k} & 0_{k\times k} & \cdots & I_{k\times k} & 0_{k\times k} \end{bmatrix}_{nk\times nk},$$

$$B = \begin{bmatrix} I_{k\times k} \\ 0_{k\times k} \\ \vdots \\ 0_{k\times k} \\ 0_{k\times k} \end{bmatrix}_{nk\times k}, \qquad C = \begin{bmatrix} N_1 & N_2 & \cdots & N_{n-1} & N_n \end{bmatrix}_{m\times nk}. \qquad (4.7b)$$

$$\hat{g}(s) = \frac{\beta_1 s^{n-1} + \beta_2 s^{n-2} + \cdots + \beta_{n-1} s + \beta_n}{s^n + \alpha_1 s^{n-1} + \alpha_2 s^{n-2} + \cdots + \alpha_{n-1} s + \alpha_n}$$

$$A = \begin{bmatrix} -\alpha_1 & -\alpha_2 & \cdots & -\alpha_{n-1} & -\alpha_n \\ 1 & 0 & \cdots & 0 & 0 \\ 0 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & 0 \end{bmatrix}_{n\times n}, \qquad B = \begin{bmatrix} 1 \\ 0 \\ \vdots \\ 0 \\ 0 \end{bmatrix}_{n\times 1},$$

$$C = \begin{bmatrix} \beta_1 & \beta_2 & \cdots & \beta_{n-1} & \beta_n \end{bmatrix}_{1\times n}$$

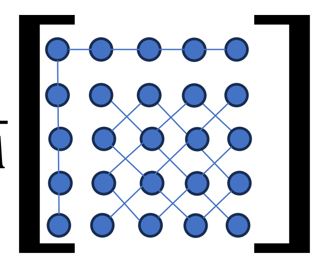
$$\hat{y}(s) = \hat{\Psi}(s)x(0) + \hat{G}(s)\hat{u}(s), \qquad \hat{\Psi}(s) := C(sI - A)^{-1},$$
$$\hat{G}(s) := C(sI - A)^{-1}B + D.$$

$$x(t) = \Phi(t, t_0)x_0 + \int_{t_0}^{t} \Phi(t, \tau)B(\tau)u(\tau)d\tau$$

$$y(t) = C(t)\Phi(t, t_0)x_0 + \int^{t} C(t)\Phi(t, \tau)B(\tau)u(\tau)d\tau + D(t)u(t),$$

$$e^{tA} = \sum_{k=0}^{\infty} \frac{t^k}{k!} A^k \quad y(t) = Ce^{(t-t_0)A}x_0 + \int_{t_0}^{t} Ce^{(t-\tau)A}Bu(\tau)d\tau + Du(t)$$

$$J_{\text{LQR}} := \int_0^{\infty} y(t)'Qy(t) + u(t)'Ru(t)\, dt,$$
$$A'P + PA + C'QC - PBR^{-1}B'P = 0,$$
$$u = -Kx, \quad K := R^{-1}B'P,$$

$\frac{1}{detA}$  ^{T}

$$\text{adj } A = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$