

> # Chapter 5, 5.3 Application: Cascading Brine Tanks

> A:=<-k1,0,0,0|k1,-k2,0,0|0,k2,-k3,0|0,0,k3,-k4>^+;

$$A := \begin{bmatrix} -k_1 & 0 & 0 & 0 \\ k_1 & -k_2 & 0 & 0 \\ 0 & k_2 & -k_3 & 0 \\ 0 & 0 & k_3 & -k_4 \end{bmatrix} \quad (1)$$

> u0:=<10,0,0,0>;

$$u_0 := \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad (2)$$

> linalg[eigenvects](A);

[-k1, 1, (3)

$$\left\{ \left[-\frac{(k_1 - k_2)(k_1 - k_3)(k_1 - k_4)}{k_3 k_2 k_1} \quad \frac{(k_1 - k_3)(k_1 - k_4)}{k_3 k_2} \quad -\frac{k_1 - k_4}{k_3} \quad 1 \right] \right\},$$

$$\left[-k_4, 1, \left\{ \left[0 \ 0 \ 0 \ 1 \right] \right\} \right], \left[-k_2, 1,$$

$$\left\{ \left[0 \quad \frac{(k_2 - k_3)(-k_4 + k_2)}{k_3 k_2} \quad -\frac{-k_4 + k_2}{k_3} \quad 1 \right] \right\}, \left[-k_3, 1,$$

$$\left\{ \left[0 \ 0 \ -\frac{-k_4 + k_3}{k_3} \ 1 \right] \right\} \right]$$

> # simple case k1=k2=k3=k4=1

> A1:=subs(k1=1,k2=1,k3=1,k4=1,A);

$$A_1 := \begin{bmatrix} -1 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 \\ 0 & 1 & -1 & 0 \\ 0 & 0 & 1 & -1 \end{bmatrix} \quad (4)$$

> LinearAlgebra[MatrixExponential](A1,t).u0;

(5)

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$$\begin{bmatrix} 10e^{-t} \\ 10te^{-t} \\ 5t^2e^{-t} \\ \frac{5}{3}t^3e^{-t} \end{bmatrix}$$

(5)