

□ state equations

1st step: form the equations, full system,
reduced to algebraic (over Dx, y, x, u)

$$\begin{aligned} (\%i1) \text{ e1: } & i1+i2+i3-i4=0; \\ (\%o1) & -i4+i3+i2+i1=0 \end{aligned}$$

$$\begin{aligned} (\%i2) \text{ e2: } & i4-i5=0; \\ (\%o2) & i4-i5=0 \end{aligned}$$

$$\begin{aligned} (\%i3) \text{ e3: } & i5+i6=0; \\ (\%o3) & i6+i5=0 \end{aligned}$$

$$\begin{aligned} (\%i4) \text{ e4: } & u1=v1; \\ (\%o4) & u1=v1 \end{aligned}$$

$$\begin{aligned} (\%i5) \text{ e5: } & u2=v1; \\ (\%o5) & u2=v1 \end{aligned}$$

$$\begin{aligned} (\%i6) \text{ e6: } & u3=v1; \\ (\%o6) & u3=v1 \end{aligned}$$

$$\begin{aligned} (\%i7) \text{ e7: } & u4=v2-v1; \\ (\%o7) & u4=v2-v1 \end{aligned}$$

$$\begin{aligned} (\%i8) \text{ e8: } & u5=v3-v2; \\ (\%o8) & u5=v3-v2 \end{aligned}$$

$$\begin{aligned} (\%i9) \text{ e9: } & u6=v3; \\ (\%o9) & u6=v3 \end{aligned}$$

$$\begin{aligned} (\%i10) \text{ e10: } & i1=C1*Du1; \\ (\%o10) & i1=Du1 C1 \end{aligned}$$

$$\begin{aligned} (\%i11) \text{ e11: } & u2=R1*i2; \\ (\%o11) & u2=i2 R1 \end{aligned}$$

$$\begin{aligned} (\%i12) \text{ e12: } & i3=0; \\ (\%o12) & i3=0 \end{aligned}$$

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[ (%i13) e13: u4=R2*i4;
  (%o13) u4 = i4 R2

[ (%i14) e14: i5=C2*Du5;
  (%o14) i5 = Du5 C2

[ (%i15) e15: u6=A*u3;
  (%o15) u6 = u3 A

[ (%i16) S: [e1, e2, e3, e4, e5, e6, e7, e8, e9, e10, e11, e12, e13, e14, e15];
  (%o16) [ - i4 + i3 + i2 + i1 = 0 , i4 - i5 = 0 , i6 + i5 = 0 , u1 = v1 , u2 = v1 , u3 =
v1 , u4 = v2 - v1 , u5 = v3 - v2 , u6 = v3 , i1 = Du1 C1 , u2 = i2 R1 , i3 = 0 , u4 = i4
R2 , i5 = Du5 C2 , u6 = u3 A ]

[
  2nd step: eliminate y vector

[ (%i17) y: [i1, i2, i3, i4, i5, i6, u2, u3, u4, u6, v1, v2, v3];
  (%o17) [ i1 , i2 , i3 , i4 , i5 , i6 , u2 , u3 , u4 , u6 , v1 , v2 , v3 ]

[ (%i18) SE: eliminate(S, y);
  (%o18) [ - A ((Du1 C1 - Du5 C2) R1 + u1) , - A
(- Du1 C1 R1 R2 + u1 (- R2 - R1) + u1 A R1 - u5 R1) ]

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  3rd step: solve over Dx

[ (%i19) SE: solve(SE, [Du1, Du5]);
  (%o19) [ [ Du1 =  $\frac{(u1 A - u5 - u1) R1 - u1 R2}{C1 R1 R2}$  , Du5 =  $\frac{u1 A - u5 - u1}{C2 R2}$  ] ]

[ (%i20) SE1: ratsimp(SE[1][1], u1, u5);
  (%o20) Du1 = -  $\frac{u1 (R2 + (1 - A) R1) + u5 R1}{C1 R1 R2}$ 

[ (%i21) SE2: ratsimp(SE[1][2], u1, u5);
  (%o21) Du5 = -  $\frac{u1 (1 - A) + u5}{C2 R2}$ 

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4th step: exclude memory elements
from the equation system; solve over y

(%i22) 0: [e1, e2, e3, e4, e5, e6, e7, e8, e9, e11, e12, e13, e15];

(%o22) [- i4 + i3 + i2 + i1 = 0 , i4 - i5 = 0 , i6 + i5 = 0 , u1 = v1 , u2 = v1 , u3 =
v1 , u4 = v2 - v1 , u5 = v3 - v2 , u6 = v3 , u2 = i2 R1 , i3 = 0 , u4 = i4 R2 , u6 = u3 A]

(%i23) OE: solve(0, y);

(%o23) [[i1 = $\frac{u1 \left((A - 1) R1 - R2 \right) - u5 R1}{R1 R2}$, i2 = $\frac{u1}{R1}$, i3 = 0 , i4 = $\frac{u1 (A - 1) - u5}{R2}$,
i5 = $\frac{u1 (A - 1) - u5}{R2}$, i6 = $-\frac{u1 (A - 1) - u5}{R2}$, u2 = u1 , u3 = u1 , u4 = u1 (A - 1) - u5 ,
u6 = u1 A , v1 = u1 , v2 = u1 A - u5 , v3 = u1 A]]