Example of computation for the Index of a DAE

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> restart:
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The DAE

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> EQ1 := diff(x(t),t)+diff(y(t),t)+diff(z(t),t)-x(t)+y(t)*z(t) ;
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$$EQ1 := \frac{d}{dt}x(t) + \frac{d}{dt}y(t) + \frac{d}{dt}z(t) - x(t) + y(t)\,z(t) \tag{1}$$

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> EQ2 := diff(x(t),t)-diff(z(t),t)-f(t) ;
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$$EQ2 := \frac{d}{dt}x(t) - \left(\frac{d}{dt}z(t)\right) - f(t) \tag{2}$$

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> EQ3 := 2*diff(x(t),t)+diff(y(t),t)+z(t)-1 ;
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$$EQ3 := 2\left(\frac{d}{dt}x(t)\right) + \frac{d}{dt}y(t) + z(t) - 1 \tag{3}$$

Try to eliminate the derivative on the 3rd equation

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> EQ3bis := EQ3 - EQ1 - EQ2 ;
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$$EQ3bis := z(t) - 1 + x(t) - y(t)\,z(t) + f(t) \tag{4}$$

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> DEQ3bis := diff(EQ3bis,t) ;
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$$DEQ3bis := \frac{d}{dt}z(t) + \frac{d}{dt}x(t) - \left(\frac{d}{dt}y(t)\right)z(t) - y(t)\left(\frac{d}{dt}z(t)\right) + \frac{d}{dt}f(t) \tag{5}$$

Solve EQ1 and EQ2 respect to y' and z'

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> SOL1 := solve( {EQ1,EQ2},diff({y(t),z(t)},t) ) ;
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$$SOL1 := \left\{\frac{d}{dt}y(t) = -2\left(\frac{d}{dt}x(t)\right) + f(t) + x(t) - y(t)\,z(t),\ \frac{d}{dt}z(t) = \frac{d}{dt}x(t) - f(t)\right\} \tag{6}$$

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> subs(SOL1,DEQ3bis) ; EQ3tris := solve( %,{diff(x(t),t)} ) ;
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$$2\left(\frac{d}{dt}x(t)\right) - f(t) - \left(-2\left(\frac{d}{dt}x(t)\right) + f(t) + x(t) - y(t)\,z(t)\right)z(t) - y(t)\left(\frac{d}{dt}x(t) - f(t)\right) + \frac{d}{dt}f(t)$$

$$EQ3tris := \left\{\frac{d}{dt}x(t) = \frac{-f(t) - z(t)\,f(t) - z(t)\,x(t) + y(t)\,z(t)^2 + y(t)\,f(t) + \frac{d}{dt}f(t)}{-2 - 2\,z(t) + y(t)}\right\} \tag{7}$$

Thus, the ODE is

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> ODE1 := subs(EQ3tris,lhs(SOL1[1])-rhs(SOL1[1])) ;
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$$ODE1 := \frac{d}{dt}y(t) \tag{8}$$

$$+\frac{2\left(-f(t)-z(t)f(t)-z(t)x(t)+y(t)z(t)^2+y(t)f(t)+\frac{d}{dt}f(t)\right)}{-2-2z(t)+y(t)}-f(t)$$

$$-x(t)+y(t)z(t)$$

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> ODE3 := subs(EQ3tris,lhs(SOL1[2])-rhs(SOL1[2])) ;
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$$ODE3 := \frac{d}{dt}z(t)-\frac{-f(t)-z(t)f(t)-z(t)x(t)+y(t)z(t)^2+y(t)f(t)+\frac{d}{dt}f(t)}{-2-2z(t)+y(t)}+f(t) \quad (9)$$

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> ODE2 := lhs(op(EQ3tris))-rhs(op(EQ3tris)) ;
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$$ODE2 := \frac{d}{dt}x(t)-\frac{-f(t)-z(t)f(t)-z(t)x(t)+y(t)z(t)^2+y(t)f(t)+\frac{d}{dt}f(t)}{-2-2z(t)+y(t)} \quad (10)$$