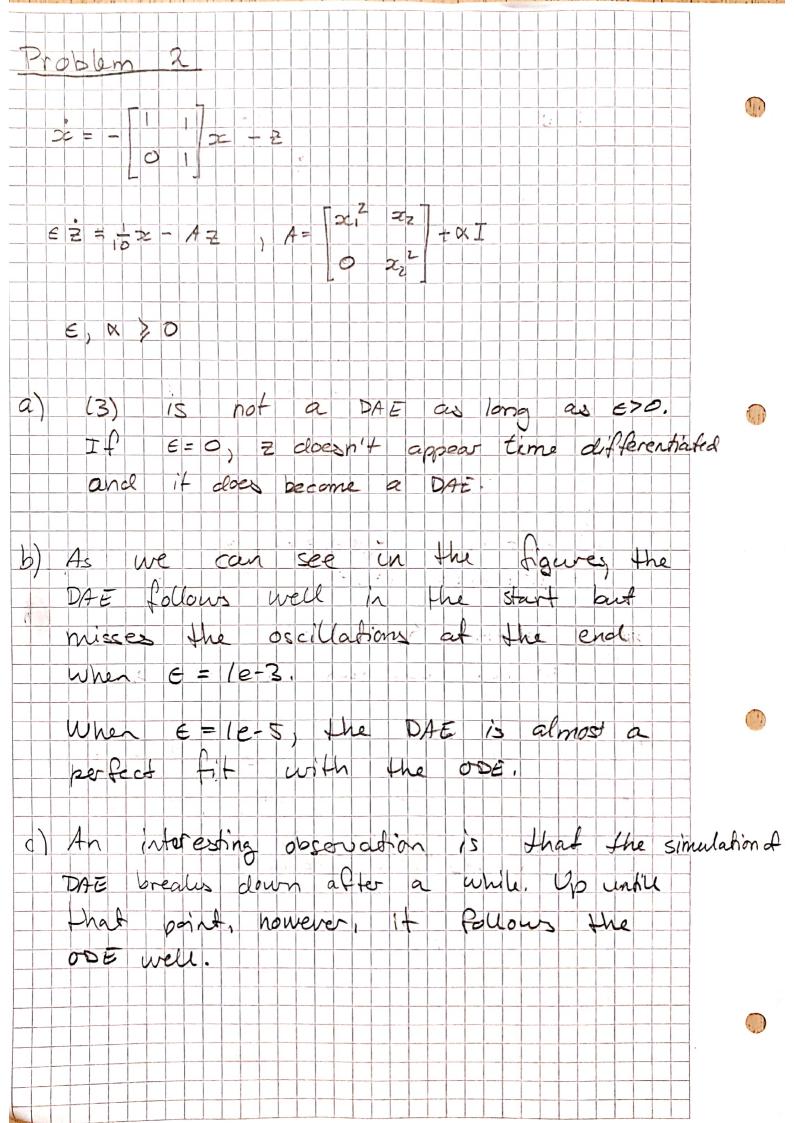
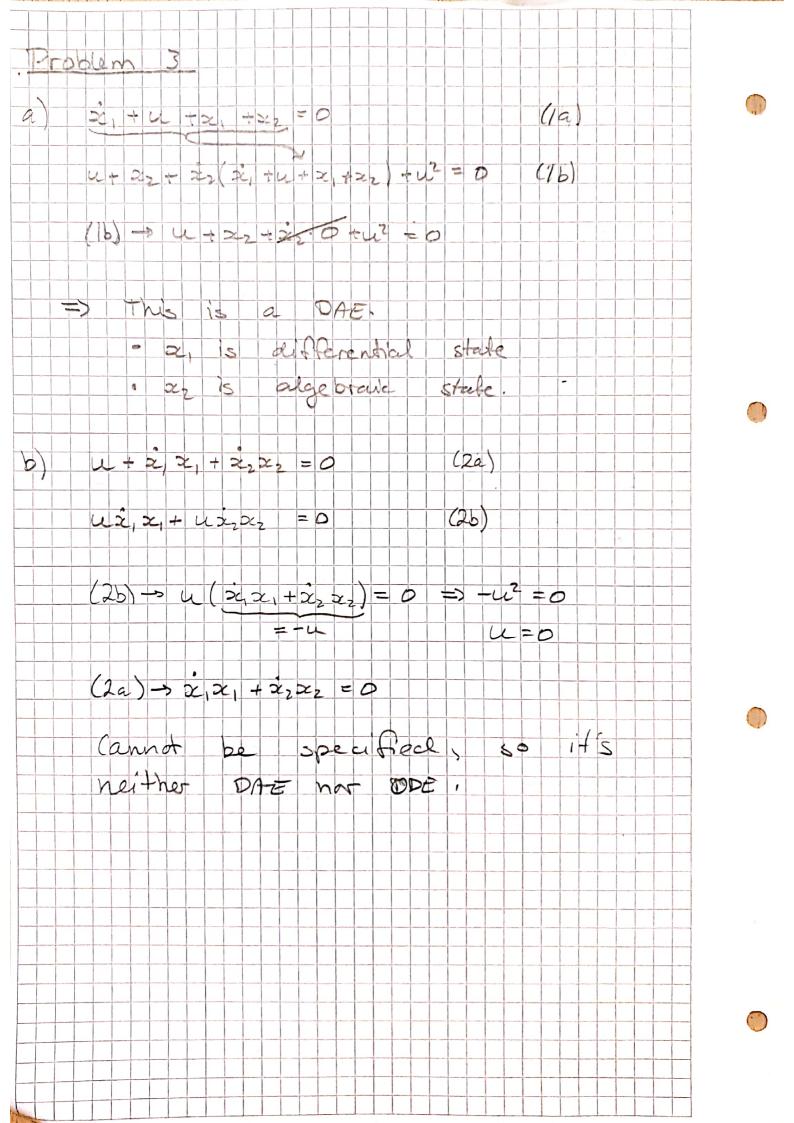
Assignment 6 Eirih Falch TTK4130 Problem 1  $x_1 = x_1 + x_2 + z$ 0 = = (x+x2+1) = g(x,z,u) a) (1) is a DAE because it contains states that doesn't apper time differentiated, namely the Z state. ()  $\frac{d}{dt} g = x_1 \dot{x}_1 + x_2 \dot{x}_2 = x_1(x_1 + x_2 + z_1) + x_2(z + u_1) = 0$ = 2, + 2, 2 + 2, 2 + 2, 2 + 2, 4  $= x^2 + 2(2(x+u) + 2(x+xz) = 0$ 0= (1) = x1+x2 = 0 (0) some x => not full rank for all &  $\frac{d}{dt}(1) = 2x_1 + x_2(x_1 + u) + x_2(x_1 + u) + \frac{1}{2}(x_1 + x_2) + \frac{1}{2}(x_1 + x_2) = 0$ = 2x, (2, +x2+2) +x2(x1+x2+2+4)+(z+4)(x,+4) + Z(x1+x2+2+2+u)+ z(x,+x2)  $\frac{1}{2} = \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) + \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) = \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) + \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) = \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) + \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) = \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) + \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) = \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) = \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) + \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) = \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) + \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2} \right) = \frac{1}{x_1 + \alpha_2} \left( \frac{1}{x_2}$ b) Index 2



d) X>0:  $g(x,z) = \frac{1}{10} \times - \left[\alpha + x,^2 + x_2\right] \left[\frac{z}{z}\right]$  $= \begin{bmatrix} 2 \\ 10 \end{bmatrix} - \frac{2}{2} \begin{bmatrix} (0 + 2^{\frac{7}{2}}) - \frac{2}{2} \\ 2 \end{bmatrix} + \frac{2}{2} \begin{bmatrix} 2 \\ 2 \end{bmatrix} + \frac{2}{2} \begin{bmatrix} 2 \\ 2 \end{bmatrix} \rightarrow 0$  $\frac{2z}{10} + \frac{2}{2z} (0 + \frac{z^2}{2z})$ x-2,2 -22 Q -22 The dynamics of  $\epsilon z = g(x, z)$  we always stable be cause  $\lambda \leq 0$ . When a > 0) 23 is always full rank, so Tilehonous theorem holas for all & When x = 0  $\frac{\partial g}{\partial x}$  is singular when  $x_2 = 0$  or  $x_1 = 0$  or both. This happens at t=1,2 and explains our observations in c) that the DAE breaks down.



Problem 4 (10a) = f 12 + u + tanh(u z) + x 2 = 0 (10b) = q tan (24-2) = 6 a) (10a) f(x,x,z,u) =0 20 = 1+(1-tanh 2(ux)) u = 1+u - u fant (uz) = 0 for (x,u) = (0,-1) Since is not full runk for every (x, u), by the IIT, (10) connot be written as a semi-explicit DAE. b)  $\begin{bmatrix} \partial + \partial + \end{bmatrix} = \begin{bmatrix} 1 + u - u + anh^2(u \dot{z}) \end{bmatrix} \approx 0$ tanh (2u-2) -/ => Not always full rank -s (10) does not always poorsicle a well-defined trajectory. c) = tanh(2u-z)-1 = 0 3 2u-z -> 00 og full rank for all 2,2, u and is therefore index !