Lab 3 MM

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Exercise 1

Make an implementation of the Fadeev algorithm to compute the transfer function. Use the following header:

```
%% Algorithm for computing transfer function from state-space representation
%    Inputs: state-space representation by specifying A, B, C, D
%    outputs: coefficients of the numerator polynomial b of transfer function,
%    the coefficients of the denominator polynomial a of transfer function
%    and a cell array S containing S1 through Sn
function [b,a,S] = Fadeev(A,B,C,D)
```

Ensure that you properly test it and verify it with the functionality in the control systems toolbox. You are expected to be able to use the Fadeev algorithm by hand during the exam, hence you can use your implementation to verify your skills. Some systems to test on:

$$x'(t) = \begin{pmatrix} 0 & 0 & 2 \\ 1 & 0 & 1 \\ 0 & 1 & 3 \end{pmatrix} x(t) + \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} u(t) \tag{1}$$

$$y(t) = \begin{pmatrix} 0 & 0 & 1 \end{pmatrix} x(t) + 2u(t) \tag{2}$$

$$x[k+1] = \begin{pmatrix} 8 & 24 & 0 \\ \frac{1}{2} & 0 & 0 \\ 0 & 2 & 0 \end{pmatrix} x[k] + \begin{pmatrix} \frac{1}{4} \\ 0 \\ 0 \end{pmatrix} u[k] \tag{3}$$

$$y[k] = \begin{pmatrix} 0 & 0 & 1 \end{pmatrix} x[k] + u[k] \tag{4}$$

$$x'(t) = \begin{pmatrix} -4 & -2 & 0 & 0 \\ 3 & -1 & 0 & 0 \\ 0 & 0 & -1 & 1 \\ 0 & 0 & 1 & -1 \end{pmatrix} x(t) + \begin{pmatrix} 1 \\ 2 \\ 0 \\ 0 \end{pmatrix} u(t) \tag{5}$$

$$y(t) = \begin{pmatrix} 2 & 0 & 0 & 1 \end{pmatrix} x(t) - u(t) \tag{6}$$

Also make them by hand to practice!

Exercise 2

Use the `residue` function to determine the partial fraction expansion of the discrete-time transfer functions:

1.
$$H(z) = \frac{(z+\frac{1}{4})(z-\frac{1}{3})(z+\frac{1}{3})}{z^3 - \frac{1}{4}z^2 - \frac{1}{4}z + \frac{1}{16}}$$

2.
$$H(z) = \frac{z^2 + \frac{1}{3}z - \frac{1}{12}}{z^3 - \frac{4}{3}z^2 + \frac{5}{6}z - \frac{1}{6}}$$

Exercise 3

In section 4.6.2 of the lecture notes there are two definitions of the controllable canonical form and it is mentioned that they are related by a linear transform. Find T.