Brian Masse

Dr. Hammock

MTH20D

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*Matlab HW4*

**Exercise 4.1**

**Part A**

B = [1.2, 2.5; 4, 0.7];

B =

1.2000 2.5000

4.0000 7.0000

**Part B**

[eigVectors, eigValues] = eig( B )

eigValues =

0.650087273644288 -0.589893864978993

0.759859550605068 0.807480791140040

eigVectors =

4.122144385112380 0

0 -2.222144385112380

**Exercise 4.2**

**Part A**

A = [ 3, 4; -1, -2 ]

A =

3 4

-1 -2

**Part B**

[eigVectors, eigValues] = eig( A )

eigVectors =

0.970142500145332 -0.707106781186547

-0.242535625036333 0.707106781186547

eigValues =

2 0

1. -1

**Part C**

y1 = c1 \* exp(1) ^ ( eigValues(1, 1) \* t ) \* eigVectors(: , 1);

y2 = c2 \* exp(1) ^ ( eigValues(2, 2) \* t ) \* eigVectors(: , 2);

y = y1 + y2;

A blue text on a white background

Description automatically generated

Depending on the starting condition (the value of c1), the value of x either approaches negative infinity while the value of y approaches infinity, or the value of x approaches infinity while the value of y approaches negative infinity.

**Part D**

**A screenshot of a computer

Description automatically generated**

Yes, this answer exemplifies the behavior I identified in part c

**Exercise 4.3**

**Part A**

A = [2.7, -1; 4.1, 3.7]

[eigVectores, eigValues] = eig( A )

A =

2.700000000000000 -1.000000000000000

4.100000000000000 3.700000000000000

eigVectores =

-0.109343504210174 + 0.429094895634507i -0.109343504210174 - 0.429094895634507i

0.896616734523426 + 0.000000000000000i 0.896616734523426 + 0.000000000000000i

eigValues =

3.200000000000000 + 1.962141687034858i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i 3.200000000000000 - 1.962141687034858i

**Part B**

y1 = c1 \* exp(1) ^ ( eigValues(1, 1) \* t ) \* eigVectors(: , 1);

y2 = c2 \* exp(1) ^ ( eigValues(2, 2) \* t ) \* eigVectors(: , 2);

y = y1 + y2;

A close-up of numbers

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**Part C**

A screenshot of a computer

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The eigen values of this system of equations were 3.2 +- Bi. Since a=3.2 > 0, the e ^ (at) expression grows to infinity as t increases.

**Exercise 4.4**

**Part A**

A = [1.25, -0.97, 4.6; -2.6, -5.2, -0.31; 1.18, -10.3, 1.12]

[eigVectors, eigValues] = eig(A)

eigVectors =

Columns 1 through 2

0.735103536321409 + 0.000000000000000i 0.449031928453424 + 0.259118786157820i

-0.196145936873525 + 0.000000000000000i -0.337494431036665 + 0.224201610414725i

0.648960370389260 + 0.000000000000000i -0.753033152521308 + 0.000000000000000i

Column 3

0.449031928453424 - 0.259118786157820i

-0.337494431036665 - 0.224201610414725i

-0.753033152521308 + 0.000000000000000i

eigValues =

Columns 1 through 2

5.569771441242941 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i -4.199885720621474 + 2.660595237935089i

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

Column 3

0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i

-4.199885720621474 - 2.660595237935089i

**Part B**

The system is unstable: the first eigen value has a real component great than 0. This means that at least on of the exponential terms with approach infinity as t increases, meaning the whole system approaches infinity, and thus is unstable

**Exercise 4.5**

**Part A**

A = [-0.0558 -0.9968 0.0802 0.0415; 0.598 -0.115 -0.0318 0; -3.05 0.388 -0.465 0; 0 0.0805 1 0];

B = [0.01; -0.175; 0.153; 0];

[eigVectors, eigValues] = eig(A)

eigVectors =

Columns 1 through 2

0.199374640137239 - 0.106271229547151i 0.199374640137239 + 0.106271229547151i

-0.077977305236739 - 0.133260428240184i -0.077977305236739 + 0.133260428240184i

-0.016547449083871 + 0.666768207597794i -0.016547449083871 - 0.666768207597794i

0.693010617551841 + 0.000000000000000i 0.693010617551841 + 0.000000000000000i

Columns 3 through 4

-0.017177857798322 + 0.000000000000000i 0.006721774358807 + 0.000000000000000i

-0.011827816177923 + 0.000000000000000i 0.040421900660712 + 0.000000000000000i

-0.489531260037862 + 0.000000000000000i -0.010525414999835 + 0.000000000000000i

0.871736295798027 + 0.000000000000000i 0.999104650842706 + 0.000000000000000i

eigValues =

Columns 1 through 2

-0.032935458097396 + 0.946653235187099i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i -0.032935458097396 - 0.946653235187099i

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

Columns 3 through 4

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

-0.562651115485759 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i -0.007277968319449 + 0.000000000000000i

**Part B**

This system is asymptotically stable, since all the real components of the eigen values are negative, meaning all the exponential terms in the solution go to 0 as t increases.

**Part C**

the fourth eigen value is very close to 0. In the associated eigen vector the fourth component (x4 = pitch rate) is nearly 1. This suggests that the eigenvector / value are most closely related to the pitch of the plane.

**Exercise 4.6**

**part A**

ans =

0 0.070000000000000 0 -0.010000000000000

0 -1.225000000000000 0 0.175000000000000

0 1.071000000000000 0 -0.153000000000000

0 0 0 0

**Part B**

ans =

0 0.050000000000000 0 -0.001000000000000

0 -0.875000000000000 0 0.017500000000000

0 0.765000000000000 0 -0.015300000000000

0 0 0 0

**Part C**

**A + B\*F**

ans =

-0.055800000000000 -0.946800000000000 0.080200000000000 0.040500000000000

0.598000000000000 -0.990000000000000 -0.031800000000000 0.017500000000000

-3.050000000000000 1.153000000000000 -0.465000000000000 -0.015300000000000

0 0.080500000000000 1.000000000000000 0

eigVectors =

Columns 1 through 2

-0.190613894122166 + 0.000071205250351i -0.190613894122166 - 0.000071205250351i

-0.066835246548876 + 0.112601603593222i -0.066835246548876 - 0.112601603593222i

0.252053236780036 - 0.597092719268404i 0.252053236780036 + 0.597092719268404i

-0.725582329863229 + 0.000000000000000i -0.725582329863229 + 0.000000000000000i

Columns 3 through 4

-0.019657016636972 + 0.000000000000000i -0.087341952341295 + 0.000000000000000i

-0.035550723966758 + 0.000000000000000i -0.078915297371967 + 0.000000000000000i

0.090767200904648 + 0.000000000000000i -0.587905087259993 + 0.000000000000000i

-0.995043246779912 + 0.000000000000000i 0.800319540918329 + 0.000000000000000i

eigValues =

Columns 1 through 2

-0.339965554948602 + 0.810422561268811i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i -0.339965554948602 - 0.810422561268811i

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

Columns 3 through 4

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

-0.088343263380559 + 0.000000000000000i 0.000000000000000 + 0.000000000000000i

0.000000000000000 + 0.000000000000000i -0.742525626722238 + 0.000000000000000i

The eigen values of A + BF are different than A.

**Part D**

the vector F = [0, 2.6, 0, -0.09] satisfies the given constraints