**W9 InLab Activity: Name: \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_**

*first*

*last*

**Summer 2022**

**Problem 1: Solve this DE using Eigenvalues and Eigenvectors**

Solve the given initial value problem: **IC:**

**a.** First find the eigenvalues of the matrix .

The characteristic equation is:

So, the eigenvalues are and

**b.** Is the system stable or unstable?

**c.** Find the corresponding eigenvectors.

**i.** Case : Show work then fill on the boxes.

**ii.** Case : Show work then fill on the boxes.

The matching eigenvectors are: and

**d.** Write out the general solution using constants and . Recall our **EEE** mnemonic. Each **fundamental solution** is a scalar function of time involving the **E**xponential of an **E**igenvalue, multiplied by the matching **E**igenvector.

**e.** Evaluate at time 0 to match the initial conditions:

and

The solution matching the initial conditions is:

**f.** Classify the system using the table below.

The system is a:

![A screenshot of a cell phone

Description automatically generated]()

**Problem 2: Solve the same Problem using the Laplace Transform (in Matrix Form)!**

Solve the given initial value problem: where **IC:**

**Tip:** The solution in the time-domain is . Denote the solution is the s-domain as or just for short.

**a.** Recalling that the Laplace Transform is linear, what is the Laplace transform of the **RHS**?

**Hint:** the matrix *A* can be treated just like a constant.

**b.** What is the transform of the **LHS**? Use the fundamental derivative identity!

Combining the two sides and solving for you can show the solution is:

**c.** Write out the matrix where denotes the identity matrix.

**d.** Give the **determinant** of this matrix. It will be a quadratic polynomial in the s variable. Factor it!

**Tip:** Compare your answer to the characteristic polynomial in Problem 1.

**e.** Find the **inverse** of the matrix . Don't forget to divide by the determinant!

**f.** Now solve for using the formula given previously:

**g.** Solve in the time domain.

**i.** The partial fraction for the top component of is:

Find the top component in the **time domain**.

**ii.** The partial fraction for the bottom component of is:

Find the bottom component in the **time domain**.

**h.** Are these components the same as you found in **Problem 1**? Yes or No?