APMA 0350 – PROGRAMMING ASSIGNMENT 3

Instructions: In the problems below, please take a screenshot of your code and your result/plot, and include it in your assignment.

Problem 1: (10 points, 5 points each) Use the pplane app to plot the phase portraits of the following systems.

(a) (Click on at least five solutions)

$$\mathbf{x}' = A\mathbf{x} \qquad A = \begin{bmatrix} 1 & 2 \\ -5 & -1 \end{bmatrix}$$

(b) (Click on at least 12 solutions, three in each of the 4 regions)

$$\mathbf{x}' = A\mathbf{x} \qquad A = \begin{bmatrix} 1 & 1 \\ 4 & -2 \end{bmatrix}$$

Problem 2: (10 points, 5 points each) Use the dsolve command in Python to solve the following systems. On the next page, you can find some sample code. No phase portrait required

(a)

$$\mathbf{x}' = A\mathbf{x} \qquad A = \begin{bmatrix} 5 & -1 \\ 3 & 1 \end{bmatrix}$$

(b)

$$\mathbf{x}' = A\mathbf{x} \qquad A = \begin{bmatrix} 1 & -4 \\ 4 & -7 \end{bmatrix} \qquad \mathbf{x}(0) = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$$

Sample Code: This code solves the ODE

$$\mathbf{x}' = A\mathbf{x} \qquad A = \begin{bmatrix} 2 & 3 \\ 3 & 2 \end{bmatrix} \qquad \mathbf{x}(0) = \begin{bmatrix} 1 \\ 4 \end{bmatrix}$$

```
from sympy import *

t = symbols('t')
x1 = Function('x1')
x2 = Function('x2')
deq1 = diff(x1(t),t) - 2*x1(t)-3*x2(t)
deq2 = diff(x2(t),t) - 3*x1(t)-2*x2(t)
dsolve([deq1,deq2],ics={x1(0):1,x2(0):4})
```

Note: If you don't want initial conditions, remove the "ics" part

Note: We switch the signs because the ODE is equivalent to

$$\begin{cases} x_1'(t) - 2x_1(t) - 3x_2(t) = 0 \\ x_2'(t) - 3x_1(t) - 2x_2(t) = 0 \end{cases}$$