Assignment: <u>Module 9 Homework</u> Name: <u>Cody Strange</u> Disclaimer: This is my work, not that of others:

Total Score: 55.0

Problem 1.a score: 5.0 Problem 1.b score: 10.0 Problem 1.c score: 10.0 Problem 2 score: 10.0 Problem 3 score: 10.0 Problem 4 score: 10.0

1. The following system of equations is designed to determine the concentrations (*c*s in g/m³) in a series of coupled, well-mixed tanks as a function of mass input to each tank. The right-hand side of the equations below represent these inputs in g/day.

$$15c_1 - 3c_2 - c_3 = 4000$$
$$-3c_1 + 18c_2 - 6c_3 = 1200$$
$$-4c_1 - c_2 + 12c_3 = 2350$$

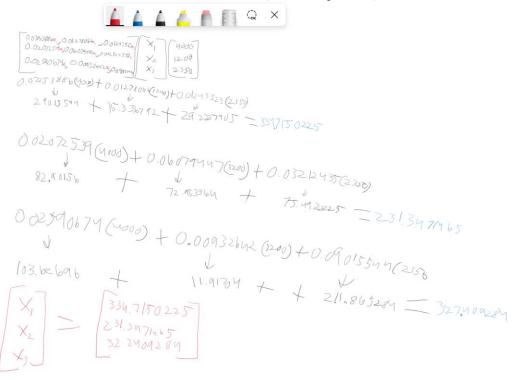
a. (5 pt) Determine the inverse of the coefficient matrix. (You can use Python to solve the inverse.)

```
question_one.py > ...
    import numpy as np

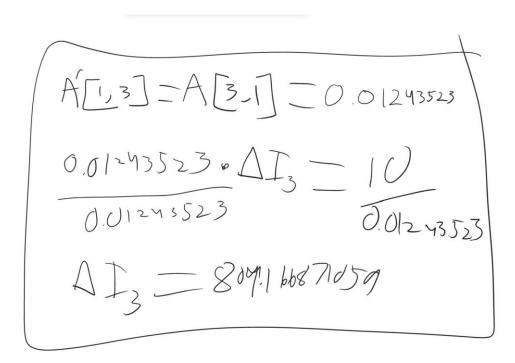
2
    A = [[15, -3, -1], [-3, 18, -6], [-4,-1, 12]]
4    b = [4000,1200,2350]
5    inverse_A = np.linalg.inv(A)
6    print(inverse_A)

[[0.07253886 0.01278066 0.01243523]
    [0.02072539 0.06079447 0.03212435]
    [0.02590674 0.00932642 0.09015544]]
PS D:\School\CS3320\HW\HW-9> [
```

b. (10 pt) Use the inverse to determine the solution. (Do this by hand.)



c. (10 pt) Determine how much the rate of mass input to tank 3 must increase to induce a 10 g/m3 rise in the concentration in tank 1.



804.166871059

2. (10 pt) Determine $||A||_f$, $||A||_1$, and $||A||_{\infty}$ for

Q :

 $||A||_F = 22.825424421026653$

$$A = \begin{cases} 8 & 2 & -10 \\ -9 & 1 & 1 \\ 15 & -1 & 6 \end{cases}$$

$$A = \begin{cases} 8 & 2 & -10 \\ 15 & -1 & 6 \end{cases}$$

$$A = \begin{cases} 32 & 2 + 171 = 7 \\ 32 & 2 + 171 = 7 \\ 32 & 2 + 171 = 7 \end{cases}$$

$$A = \begin{cases} 8 & 2 & -10 \\ -9 & 1 & 6 \\ 15 & -1 & 6 \end{cases}$$

$$A = \begin{cases} 8 & 2 & -10 \\ -9 & 1 & 6 \\ 15 & -1 & 6 \end{cases}$$

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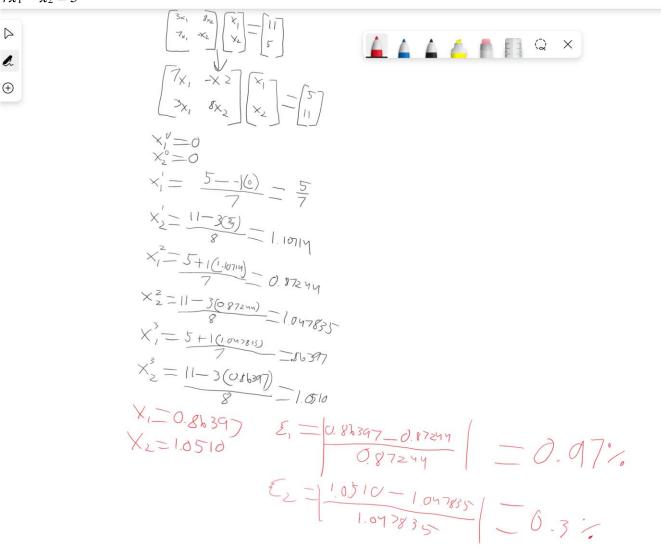
$$A = \begin{cases} 1 & 2 & 2 & 2 \\ 22 & 20 & 713 \end{cases}$$

$$A = \begin{cases} 1 & 2 & 2 & 2 & 2 \\ 22 & 2 & 2 & 2 \\ 23 & 2 & 2 & 2 \end{cases}$$

$$A = \begin{cases} 1 & 2 & 2 & 2 \\ 22 & 2 & 2 & 2 \\ 23 & 2 & 2 & 2 \\ 24 & 2 & 2 & 2 \\ 25 & 2 & 2 \\ 25 & 2 & 2 & 2 \\ 25 & 2 & 2 \\ 25 & 2 & 2 \\ 25 & 2 & 2 & 2 \\ 25 & 2 & 2 \\ 25 & 2 & 2 \\ 25 & 2 & 2 \\$$

 $||\mathbf{A}||_{inf} = 22$

$$7x_1-x_2=5$$



4. (10 pt) Use the Gauss-Seidel method (a) without relaxation and (b) with relaxation ($\lambda = 1.2$) to solve the following set of linear equation to meet an error tolerance of $\varepsilon_s = 5\%$. If necessary, rearrange the equations to achieve convergence.

$$2x_1 - 6x_2 - x_3 = -38$$

$$-3x_1 - x_2 + 7x_3 = -34$$

$$-8x_1 + x_2 - 2x_3 = -20$$

Without Relax

```
X
   f(x) = 1.2 \left( \frac{\left(-20 - \left(7.9416158882\right) + 2\left(-2.0521466768\right)\right)}{9} \right) + \left(1 - 1.2\right)3.96200000622
                      \frac{\left(-38 - \left(2(4.01448638503)\right) + \left(-2.0521466768\right)\right)}{2} + \left(1 - 1.2\right)7.9416158882
   h(x) = 1.2 \frac{\left( \left( -34 + 3\left( 4.01448638503 \right) + 8.02790071173 \right) \right)}{7} + \left( 1 - 1.2 \right) \left( -2.0521466768 \right)
                                                                                                                                                                                                                                         ×
   f(x)
                                                                                                                                                                                                                  = 4.01448638503
    g(x)
                                                                                                                                                                                                                  = 8.02790071173
    h(x)
                                                                                                                                                                                                                = -1.97733754461
     \frac{\left(4.01448638503 - 3.96200000622\right)}{100} \cdot 100
                 4.01448638503
                                                                                                                                                                                                                  = 1.30742450655
    \frac{\left(8.02790071173 - 7.9416158882\right)}{2.00700071173} \cdot 100
                 8.02790071173
                                                                                                                                                                                                                  = 1.07481179238
    \frac{\left(-1.97733754461 - -2.0521466768\right)}{-1.97733754461} \cdot 100
= -3.78332634172 -
```