Written Homework #5
ChE 231
Spring 2019

Problem 1. Consider a continuous stirred tank reactor in which the following reactions occur: A → B, B → C, C → B and B → D. The reactor has an inlet stream with concentration C_{Af}. The reactor is described by the following steady-state mass balance equations:

$$
\begin{aligned}
0 &= -5C_A + 2C_{Af} \\
0 &= 3C_A - 20C_B + 9C_C \\
0 &= 6C_B - 11C_C
\end{aligned}
$$

Use Gauss-Jordan elimination to find the matrix inverse and to find the solution C_A, C_B and C_C.

Problem 2. Consider the following reaction network: $A \to D$, $2A \to 2B$, $4B + 3C \to 2A$. The rates of these three reactions are denoted r_1, r_2 and r_3, respectively. Assume that the reacting species A, B and C are supplied at rates $r_{A0} = 1$, $r_{B0} = 2$ and $r_{C0} = 6$, respectively.

1. Show that mass balances on the species A, B and C yield a linear algebraic equation system that can be written as follows where $\mathbf{x} = [r_1 \; r_2 \; r_3]^T$,

$$
\begin{bmatrix}
-1 & -2 & 2 \\
0 & -2 & 4 \\
0 & 0 & -3
\end{bmatrix}
\mathbf{x} =
\begin{bmatrix}
-1 \\
2 \\
-6
\end{bmatrix}
$$

2. Perform Gauss-Jordan elimination on the matrix $\mathbf{A}$ to find the inverse matrix $\mathbf{A}^{-1}$.

3. Use $\mathbf{A}^{-1}$ to determine the solution $\mathbf{x}$. Calculate the 2-norm of $\mathbf{x}$.